SEPTEMBER, 1957
No. 224

ASTM Bulletin

THIS ISSUE—

Book of Standards Expands to 10 Parts—New ASTM Publications—Standards Actions—Package Power Reactor—New SBR and SBR Latex Numbers—Defense Standardization Assignments—Wood Pole Program—Technical Papers

American Society for Testing Materials

ASTM BULLETIN

SEPTEMBER 1957

Number 224

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Out of Owens-Illinois' famed Technical Center comes . . .

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1958 Book of Standards Expands to Ten Parts

GROWTH OF STANDARDS WORK REQUIRES ADDITIONAL PARTS FOR EFFICIENT PRINTING AND HANDLING

Based on extensive studies by the Staff and the Administrative Committee on Papers and Publications, the Board of Directors has decided that the 1958 Book of Standards (issued late that year and early 1959) will appear in ten Parts. It is anticipated that if the present triennial publication continues, ten Parts will suffice also for the 1961 Book, but studies will continue meanwhile on other means of issuing the standards.

The 1957 Supplements to the 7-Part 1955 Book of Standards will be issued in seven Parts, available late this year, or early next year.

Over the years various proposals have been made and given considerable study including the looseleaf form of publication, and staggering the issuance of the Parts, that is, bringing out two or three Parts in succeeding years. However, it is felt by most of those participating in the studies and by many of the members that the present system of issuing the complete Book in one year, followed by Supplements in the intervening years, is the most desirable method as long as the tremendous job of editing and printing can be handled.

Book of Standards Growth

This publication is unquestionably the Society's most important one. It is distributed world-wide and the standards in it are used to cover the production and buying of billions of dollars of materials annually. It will continue to grow because, as the technical committee work increases, many more specifications and tests will be issued.

Prior to 1939, the ASTM formally adopted standards appeared in two volumes and the so-called tentatives appeared in a separate volume. That year the triennial Book, including tentatives, was published in three Parts. Additional Parts have been added until the 1955 Book consisted of seven Parts, aggregating some 11,800 pages.

Three of the Parts by 1958 would have grown to well over 2000 pages each, and 2000 pages is about the limit of machine-binding books with thin Bible-type paper. Thinner paper used in one of the earlier editions had neither the opacity nor strength desired, and so a special lot of paper was produced and the same quality will be used in the future.

There is a tremendous wealth of technical data and information in the standards; each Part of the Book is carefully indexed and a combined Index to Standards is sent without charge annually to each member and to all who purchase the books.

Each member may request any one Part on his membership and can obtain the other Parts and Supplements by payment each year of $3 per Part.

Thus, all ten Parts of the Book and Supplements in the two succeeding years can be obtained on an annual charge of $27. It is estimated that total pages in the 1958 Book will be about 13,500. The *list price* will be about $116 for the complete set.

The Board of Directors is urging that each member carefully consider the value of having a complete set of the Book in his files, thus making available all of the specifications and tests excepting those which appear in the special

A Comparison of the 1958 with the 1955 Book of Standards and Supplements

1958 — 10 PARTS

Committees Involved		
A-1, 2, 3, 5, 6, 7, 9, 10	PART 1	Ferrous Metals (Excluding Test Methods)
B-1, 2, 3, 4, 5, 6, 7, 8, 9 F-1	PART 2	Non-Ferrous Metals, Electronics Materials (Excluding Test Methods)
E-1, 4, 7, 9, 11 and all A and B committees that have test methods	PART 3	Methods of Testing Metals (Excluding Chemical Analysis)
C-1, 2, 3, 7, 9, 11, 12 D-4, 8, 18, E general	PART 4	Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils
C-4, 8, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 E-5, 6 and general	PART 5	Masonry Products, Ceramics, Thermal Insulation, Sandwich and Building Constructions, Fire Tests
D-6, 7, 10, 14, 23, 25, Leather and E general	PART 6	Wood, Paper, Adhesives, Shipping Containers, Cellulose, Casein, Leather
D-2, E general	PART 7	Petroleum Products, Lubricants, Tank Measurements, Engine Tests
D-1, 3, 5, 15, 16, 17 E general	PART 8	Paint, Naval Stores, Hydrocarbons, Coal and Coke, Gaseous Fuels, Engine Antifreezes
D-9, 11, 20, 24 E general	PART 9	Plastics, Electrical Insulation, Rubber, Carbon Black
D-12, 13, 19, 21, 22 C-23	PART 10	Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes, Sorptive Mineral Materials

1955 — 7 PARTS

PART 1	Ferrous Metals
PART 2	Non-Ferrous Metals
PART 3	Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, and Soils
PART 4	Paint, Naval Stores, Wood, Fire Tests, Cellulose, Wax Polishes, Sandwich Constructions, Building Constructions
PART 5	Fuels, Petroleum, Aromatic Hydrocarbons, and Engine Antifreezes
PART 6	Electrical Insulation, Electronic Materials, Plastics, Rubber
PART 7	Textile, Soap, Water, Paper, Adhesives, Shipping Containers, Atmospheric Analysis

ONE IN THREE GETS ALL PARTS

The expanding Book of Standards is an outstanding technical accomplishment. It is an encyclopedia of materials data which every engineer and scientist can well afford to place in his technical library for ready reference. The triennial Book is supplemented annually to bring him the latest information. About one-third of our members buy all the parts. The annual charge method is a practical and economical way to get the complete set.

volume covering chemical analysis of metals.

The ten Parts of the 1958 Book will be issued in a period extending from November, 1958 through March, 1959. Even this spread means a terrific load on the committee officers, the Staff, and the printer. Members will be kept fully informed through the ASTM BULLETIN and special circulars on how the Parts will appear.

In August a special circular was sent to all ASTM members requesting them to indicate the Part of the Book of Standards they wish to receive on their membership. A large portion of the replies is already in and those who have not replied are urged to do so immediately so that the Society may make the alterations in mailing instructions and billing records which are an important and necessary part of the changeover from a 7- to a 10-Part Book.

Actions on Standards

The Administrative Committee on Standards is empowered to pass upon proposed new tentatives and revisions of existing tentatives and standards offered between Annual Meetings of the Society. On the dates indicated below, the Standards Committee took the following actions:

Steel

Tentative Specification for General Requirements for Delivery of Rolled Structural Steel (A 6 – 56 T) (Approved Aug. 15, 1957)

Revision.—Numerous changes have been made throughout this specification to bring it in line with industry practice.

Tentative Specification for General Requirements for Hot-Rolled and Cold Finished Carbon and Alloy Steel Bars (A 29 – 57 T) (Approved Aug. 15, 1957)

New Tentative.—This new specification has been prepared in accordance with Committee A-1's practice to separate general requirements from groups of specifications and issue the general requirements as a separate document. It is felt that such an arrangement is in the interest of greater utility. Appropriate revision has been made in the entire group of steel bar specifications to eliminate the general requirements. These revised tentatives are:

Hot Rolled Carbon-Steel Bars (A 107 – 52a T)
Cold-Finished Carbon-Steel Bars and Shafting (108 – 52 T)
Heat-Treated Alloy-Steel Bars (A 286 – 52 T)
Alloy-Steel Bars to End-Quench Hardenability Requirements (A 304 – 55 T)
Carbon-Steel Bars Subject to Mechanical Property Requirements (A 306 – 55 T)
Stress-Relief-Annealed Cold-Drawn Carbon-Steel Bars (A 311 – 52 T)
Heat-Treated Carbon-Steel Bars (A 321 – 52 T)
Hot-Rolled Alloy-Steel Bars (A 321 – 52 T)
Cold-Finished Alloy-Steel Bars (A 332 – 50 T)
Alloy-Steel Bars for Nitriding (A 355 – 52 T)
Cold-Finished Heat-Treated Alloy-Steel Bars (A 364 – 52 T)

Electrodeposited Metallic Coatings

Tentative Recommended Practice for Preparation of Iron Castings for Electroplating (B 320 – 57 T) (Approved Aug. 15, 1957)

New Tentative.—Committee B-8 has received several requests from the electroplating industry for such a specification. It is intended to assist platers in establishing and maintaining a satisfactory preplating cycle for malleable iron, gray iron, nodular iron, and white iron castings; and to indicate certain foundry practices which will facilitate subsequent finishing.

Concrete Pipe

Tentative Specification for Reinforced Concrete, Culvert, Storm, Drain, and Sewer Pipe (C 76 – 57 T) (Approved Aug. 13, 1957)

New Tentative.—Committee C-13 has combined in this new specification the desirable requirements of the Standard Specifications for Reinforced Concrete Sewer Pipe (C 75) and for Reinforced Concrete Culvert Pipe (C 76) and included manufacturing refinements and design and test requirements for stronger classes of concrete pipe than were heretofore specified in C 76. Accordingly, both Standard Specifications C 75 and C 76 are withdrawn.

Glass

Methods of Chemical Analysis of Soda-Lime Glass (C 169 – 53)

Tentative Revision.—Committee C-14 has been making a systematic review of the methods contained in these standard methods of analysis. This present revision is the result of round-robin testing work to improve the method for determination of silicon dioxide with respect to time.

Nondestructive Testing

Tentative Method for Dry Powder Magnetic Particle Inspection (E 109 – 55 T) (Approved Aug. 13, 1957)

Revision.—Committee E-7 has revised this method in response to a request from the steel industry in order that it may be suitable for reference in ASTM specifications for steel castings.

Electronic Materials

Tentative Specifications for Tungsten Wire Under 20 Mils in Diameter (F 288 – 54 T) (Approved Aug. 15, 1957)

Revision.—These specifications have been generally revised by Committee F-1 on Materials for Electron Tubes and Semiconductor Devices to eliminate certain classes of materials which are covered in other specifications and to define more thoroughly nonsag wires. Other changes include new densities, straightness requirements, slightly different physical characteristics, and limited changes in physical testing requirements.

Tentative Specifications for Round Wire for Use as Electron Tube Grid Laterals and Verticals (F 290 – 54 T) (Approved Aug. 15, 1957)

Revision.—These specifications have been revised to reflect the specification on grid lateral winding wire as now being used. The grid side-rod wire has been separated from the grid lateral winding wire and a new specification will be forthcoming, presumably within the next year, covering only grid side-rod materials. Also included are changes in physical characteristics and additional ranges of physical characteristics, methods of test, more acceptable density figures, and revised spooling requirements.

Filler Metal

Tentative Specification for Aluminum and Aluminum Alloy Welding Rods and Bare Electrodes (B 285 – 54 T) (Approved Aug. 19, 1957)

Revision.—This specification has been extensively revised by the Joint American Welding Society-ASTM Committee on Filler Metal and includes, as a new feature, the use of ASTM radiographic standards for evaluating electrodes.

NEW ASTM PUBLICATIONS

The ASTM publications described in these columns have just come off press, and may be obtained from Society Headquarters, 1916 Race St., Philadelphia, Pa.

Symposium on Titanium

HIGH interest and the exceptional rate of progress in working out the technology of titanium has resulted in an amazing number of technical papers, symposia, and special meetings or conferences to cover this progress. Apparently in recent years one sure way to assure a successful meeting has been to include a session on titanium. The ASTM has hesitated to organize technical sessions devoted to titanium because of this excellent coverage by other societies, until a real need existed. Such a need was shown first by interest in specifications. A task group was promptly formed in Subcommittee VIII of Committee B-2 on Non-Ferrous Metals and Alloys, which gradually evolved the present ASTM specifications for sponge titanium (B 299 – 55 T) and for strip, sheet, plate, bar, tube, rod and wire (B 265–52 T). Likewise, methods for chemical analysis of titanium and titanium-base alloys (E 120 – 56 T) were evolved through Committee E-3. As problems arose showing the need for good technical information on which to base specifications, it appeared desirable to encourage technical papers along testing and property evaluation lines. This, of course, is a field in which ASTM should take leadership.

The present Symposium on Titanium was organized late in 1955 as plans for the Second Pacific Area National Meeting were being formulated. Since the Pacific area is a leader in the aeronautical industry which has special interest in titanium, it seemed particularly fitting to hold such a symposium in Los Angeles. The symposium has been sponsored directly by Committee B-2 on Non-Ferrous Metals and Alloys. The Administrative Committee on Research has given encouragement and aid as an indirect sponsor. Although many of the papers on titanium submitted for this meeting did not deal directly with test procedures or properties, they have been included to make a program of wide interest.

Titles and authors of the papers appearing in this Symposium are:

Introduction—*B. W. Gonser*

Variables Affecting the Thermal Stability of Three Titanium Alloys—*F. R. Schwartzberg, N. D. Williams, and R. I. Jaffee*

The Effect of Temperature on the Uniform Elongation of Titanium Alloys—*F. C. Holden, H. R. Ogden, and R. I. Jaffee*

The Effect of Composition and Annealing Treatment on the Thermal Stability of Chromium-Molybdenum Alloys of Titanium—*H. R. Ogden, F. C. Holden and R. I. Jaffee*

Elevated-Temperature Properties of the 6 per cent Aluminum, 4 per cent Vanadium Titanium Alloy—*E. M. Parris, R. G. Sherman, and H. D. Kessler*

Development of Titanium-Base Alloys for Elevated Temperature Application—*F. A. Crossley, W. F. Carew, and H. D. Kessler*

The Effects of Carbon and Nitrogen Contamination on the Notch Tensile Properties of Titanium—*E. P. Klier and N. J. Feola*

A Micro Notched-Bar Impact Test for Titanium Alloys—*F. C. Holden, H. R. Ogden, and R. I. Jaffee*

The Measurement of Elastic Modulus of Titanium Alloys—*W. H. Graft, and W. Rostoker*

The Corrosion and Ignition of Titanium in Fuming Nitric Acid—*J. B. Rittenhouse*

Unalloyed Titanium Sheet Is Improving—*H. A. Barry and Leo Schapiro*

How Statistical Techniques Helped Achieve Better Uniformity in Unalloyed Titanium—*C. R. Smith*

Properties and Fabrication Characteristics of Wrought Titanium Products—*L. B. Stark*

Development of Standardized Specimen Preparation and Testing Techniques for Unalloyed Titanium Sheet—*R. L. Folkman and M. Schussler*

Determination of Gaseous Elements in Titanium—*R. M. Fowler*

STP No. 204. 206 pages. Price: \$4.75; to members, \$3.50.

ASTM Standards on Thermostat Metals

A collection of seven test methods relating to thermostat metals will be available soon as a separate booklet. Included are methods for flexibility, modulus of elasticity, maximum loading stress at temperature, and diamond pyramid hardness. Also included are tests for electrical resistivity and change of resistance with temperature of metals as well as a test for mean specific heat of thermal insulation.

This booklet will be useful to producers and consumers of thermostat metals and to engineers generally who are working in this field.

40 pages. Price: \$1 to members and nonmembers.

Symposium on Thermal Insulating Materials

THE PROCESS by which research establishes property values and limits for products, and, in turn, methods of test which are broadly applied and subsequently revised as experience dictates, is well illustrated in this symposium.

A 1952 symposium on the same subject pointed to the need for criteria to assure more comparable results in determinations by the ASTM Method of Test for Thermal Conductivity of Materials by Means of the Guarded Hot Plate (C 177). In this present symposium, held in February of this year by Committee C-16 on Thermal Insulating Materials, two papers present analyses and experimental procedures by which these criteria can be developed.

Two other papers deal with improvements and modifications of the apparatus within the scope of the method and its extension to uses at lower temperatures.

The phase of property values research is exemplified by two papers dealing with moisture in relation to thermal insulation. One reports on a fundamental study sponsored by Committee C-16 to evaluate a transient heat-flow method of measuring the thermal conductivity of moist insulation and the other deals with the insulation of underground piping, discussing the effect of the earth cover not only as additional thermal insulation but, more importantly, as governing the conditions affecting the durability of waterproof coverings for the insulation.

Titles and authors of these papers are:

Introduction—*H. E. Robinson*

An Improved Guarded Hot Plate Thermal Conductivity Apparatus with Automatic Controls—*Zeno Zabawsky*

The Use of Envelope Type Cold Plates in Thermal Conductivity Apparatus—*C. F. Gilbo*

Errors in Thermal Conductivity Measurement by the Guarded Hot Plate Due to Guard Ring Unbalances—*W. Woodside and A. G. Wilson*

Analysis of Errors Due to Edge Heat Loss in Guarded Hot Plates—*William Woodside*

Thermal Conductivity of Insulation Containing Moisture—*F. A. Joy*

Criteria for Testing Underground Piping Thermal Insulation—*D. D'Eustachio*

STP No. 217. 92 pages. Price: \$2.75; to members, \$2.00.

Symposia on Design and Tests of Building Structures, Seismic and Shock Loading, Glued Laminated and Other Constructions

Earthquakes can be made an interesting rather than a dangerous occurrence if proper design and the right materials of construction are used. Wood, especially in laminated form has become increasingly important in earthquake-resistant construction, but problems encountered have pointed up the need for additional design data and for further utilization as the quality of wood adhesives advances.

The two symposia included in this publication are of equal value to those in the building construction field. Both symposia were sponsored jointly by ASTM Committees D-7 on Wood and E-6 on Methods of Testing Building Constructions and held at the Second Pacific Area National Meeting in September, 1956 in the section of the country where concern with the problem of earthquake is greatest. However, there is much of interest in these papers with respect to design data and studies of various types of loads to engineers who have problems different from those encountered on the West Coast.

Titles and authors of the papers are as follows:

Seismic and Shock Loading

Introduction—*L. J. Markwardt and Ben Benioff*

Building Design for Lateral Forces—*H. J. Degenkolb*

Report on Recent Oregon Forest Products Laboratory Tests of Cantilevered Wood Mullions Fixed in Diagonally Sheathed and Plywood Panels—*Charles Peterson*

Report on U. S. Forest Products Laboratory Tests of Full-Size Structural Wood Diaphragms Made in Cooperation with State of California and U. S. Army Engineers—*R. P. A. Johnson*

Glued Laminated and Other Constructions

Introduction—*L. J. Markwardt*

Developments in Glued Laminated Construction—*R. E. Eby*

Factors Affecting Strength and Design Principles of Glued Laminated Construction—*A. B. Freas*

Range in Strength Qualities of Dimension Lumber—*L. W. Wood*

Developments in Engineered Wood Design and Construction (Other Than Glued Laminated)—*Verne Ketchum*

Developments in Softwood Plywood Design and Construction—*David Countryman*

STP No. 209. 80 pages. Price: \$2.75; to members, \$2.

Planning for Boston Meeting . . .

Members of the General Committee on Arrangements for the 1958 Annual Meeting at Boston who met recently at the Massachusetts Institute of Technology Faculty Club to discuss plans for next year's meeting. Standing (left to right): N. F. Weaver, Hospitality Subcommittee; W. L. Hyland, Transportation Subcommittee; R. S. Fox, Financial Subcommittee; R. A. Pomfret, Chairman, Publicity Subcommittee. Seated (left to right): R. P. Mahan, Chairman, New England District; M. N. Clair, Chairman, General Committee on Arrangements; W. H. Buracker, Chairman, Entertainment Subcommittee. Subcommittee chairmen not shown here are A. G. H. Dietz, Technical Program; F. J. Mardulier, Finance; J. W. Millard, Hospitality and Information; and E. F. Walsh, Photographic Exhibit.

Compilation of Chemical Compositions and Rupture Strengths of Super-Strength Alloys

This up-to-date compilation on super-strength alloys lists the names, nominal chemical composition, characteristic rupture strengths for rupture in 100 and 1000 hr, and patentees for approximately 150 domestic and 75 foreign alloys. Included in this revised edition are the ferritic (martensitic) super-strength alloys and age-hardening stainless steels. The data, obtained from all possible sources, are arranged in easy-to-read tabular form.

The compilation, originally published in 1955, was prepared by W. F. Simmons of Battelle Memorial Institute, and V. W. Krivobok of the International Nickel Co. and is issued under the auspices of Subcommittee XII of ASTM Committee A-10 on Iron Chromium, Iron-Chromium-Nickel and Related Alloys. Price: \$0.75.

1956 References on Fatigue

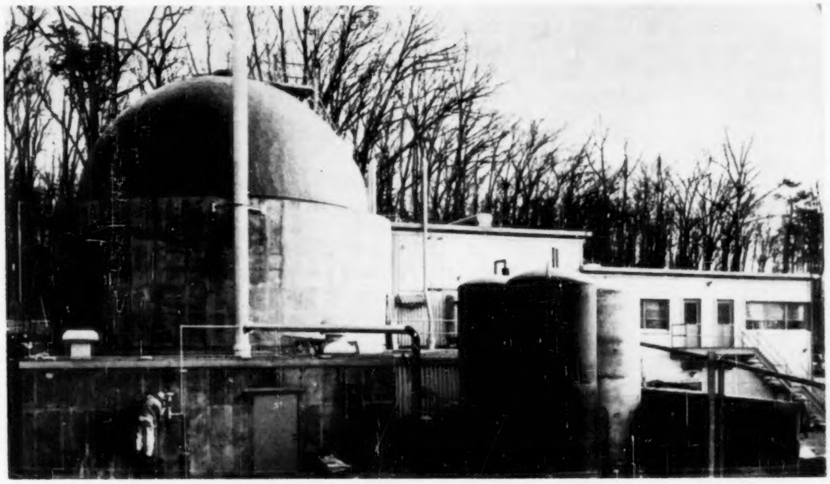
This list of references consisting of about 370 entries provides an extensive source of information on articles published in 1956 dealing with fatigue of structures and materials. An abstract of each reference is included in all but a few cases. The material is so arranged that individual references can be cut apart for filing according to any desired plan. This publication is sponsored by Subcommittee III of ASTM Committee E-9 on Fatigue.

Similar lists of references were published covering the years 1950 through 1955 and are available, from ASTM Headquarters, in a package purchase with the current edition for \$10. Price of the 1956 edition alone is \$3 (*STP 9-H*).

NOTICE

1959 San Francisco Meeting Shifted to October

By shifting the previously announced date of the 1959 Pacific Area Meeting, scheduled for San Francisco, September 14–18, but now to be held throughout the week beginning October 11, we avoid an undesirable conflict with the fall meeting of the American Chemical Society. Further announcement will be made concerning this.



APPR—

Nuclear Power in a Package

THE Army Power Package Reactor now in operation at Fort Belvoir, Va., has a gross electric power output of 2035 kw—enough to serve a community of 2000 people. In one year of operation the reactor will use about 11 lb of nuclear fuel corresponding roughly to 24 million lb of coal. The name "package reactor" derives from the concept that the components will be transportable by air and capable of erection at a remote field site in a six-month construction period. The APPR is the first of several nuclear power plants to be developed by the Atomic Energy Commission and the Department of Defense for use by the three military services. The reactor was built by ALCO Products Inc., under a fixed-price contract with the Atomic Energy Commission. Stone & Webster Engineering Corp. served as engineer-constructor for ALCO.

The plant consists of two main systems—primary and secondary—as shown in Fig. 2. The principal difference from a conventional power station lies in the primary system where nuclear reaction replaces conventional fuels. The heat transfer medium is pressurized water already proved in the Navy's nuclear submarine *Nautilus*.

The Primary and Secondary Systems

The main components of the APPR primary system are: (1) the reactor vessel and core, (2) control rods and drives, (3) two coolant circulating pumps, (4) piping, (5) the steam generator, (6) a pressurizer, (7) water purification equipment, and (8) shielding.

The reactor core forms the heart of the system. Housed in the core are 38 fuel elements, containing fully enriched uranium, together with 7 control rods—all in a grid structure of a basic 7 by 7 design with the corners missing.

Cooling water enters the reactor vessel at 431 F under pressure of 1200 psi to prevent boiling. While circulating upward between the fuel plates at 4000 gal per min, it is heated to 450 F before passing to the steam generator.

At the steam generator, heat from the high-pressure primary water is transferred to the water in the secondary system, thus producing the steam used to drive the turbine.

The cycle is completed by using special "canned-rotor" pumps to return the cooled primary water to the reactor. The two pumps are constructed primarily of 304L stainless steel and are similar to pumps used in the *Nautilus*.

The secondary system of the APPR is comprised essentially of the secondary side of the steam generator, the turbine-generator set, surface condenser and auxiliaries, feedwater heater, evaporator, pumps, and storage tanks. Since no primary water is circulated in the system, no shielding is required and the entire system, except the steam generator, is outside the vapor container.

In this system, steam is produced in the steam generator at 34,070 lb per hr under pressure of 200 psi at 407 F. The steam, which has 25 F superheat, passes through the turbine to a surface deaerating condenser and back to the steam generator through a feedwater heater.

Feedwater for the steam generator is obtained from a condenser hot well and circulated by the combination condensate hot-well and boiler-feed pump through a closed-type feedwater heater. In the feedwater heater the temperature of the water is raised to 250 F by steam bled from the turbine at about 35 psia.

Reactor Core and Vessel

The reactor core shown in Fig. 3 consists of 38 fuel rods and 7 control-rod assemblies fabricated by the Oak Ridge National Laboratory. The core and its supporting structure are housed in the stainless steel-clad reactor vessel. The vessel, measuring 47½ in. inside diameter, and 162 in. over-all length, is clad with 0.125 in. stainless steel on all surfaces in contact with primary water.

The fully enriched, uranium-dioxide fuel is incorporated into flat-plate type elements. Each fuel assembly consists of 18 fuel plates brazed into a pair of 304L stainless steel side plates. The outside plates are 27 in. long and the internal plates are 23 in. long. Each assembly has on both ends a 304L stainless steel grid adapter, or end box, attached by fusion welding.

The control rods consist of two sections: a fuel section, and an absorber section. Control-rod fuel plates are fabricated in the same manner as the stationary fuel plates. The absorber section is boron-enriched in the isotope boron-10.

Steam Generator

The steam generator has a "U"-type tube bundle with 326 tubes each ¾ in. outside diameter by 0.062 in. wall, with

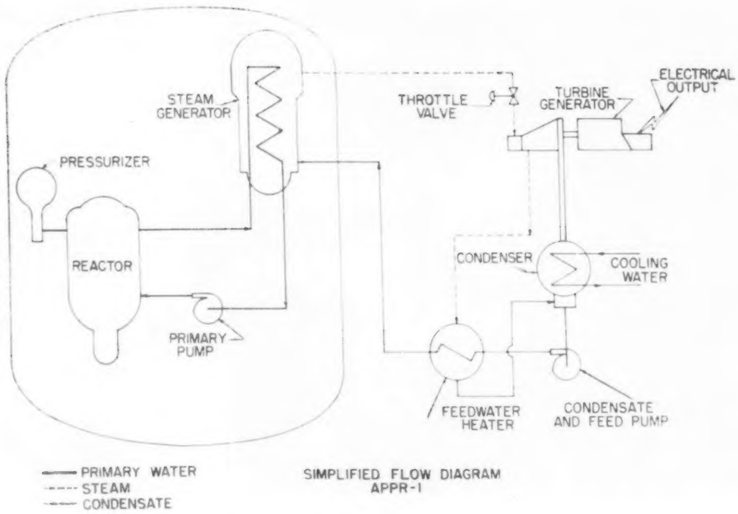


Fig. 2.—Simplified Flow Diagram.

a total effective heating surface of 836 sq ft. Inside the same shell, separated from the generating section by a baffle plate, is the superheater section, with 194 sq ft of heating surface. Hence, the total heating surface of the generator is 1030 sq ft.

The steam generator receives slightly radioactive water at 450 F from the primary system, while secondary water at 250 F enters the shell side about halfway up the steam-generating section at a full-load rate of 34,270 lb pr hr. The secondary water is converted to steam by contact with the tube bundle, which contains the heated primary water.

This secondary-system steam is used to drive the turbine downsteam in the secondary side of the plant.

Type 304L stainless steel is used as the basic corrosion-resistant material in the steam generator. In addition, all piping in the primary system is of solid stainless steel, of $\frac{3}{4}$-in. wall thickness and $12\frac{3}{4}$-in. outside diameter.

The 1200 psi operating level of the primary system is maintained by two immersion heaters housed in a stainless-clad pressurizer. The pressurizer, which is mounted on a cylinder contains sufficient steam and liquid to absorb fluctuations of primary liquid volume without excessive pressure changes

Water Purification

Water in the primary system is thoroughly purified to protect against corrosion. The primary system contains about 1300 gal of water which is circulated at a rate of about 4000 gal per min. This water is maintained at a total solid concentration of not more than 2 ppm.

Portions of the water in the primary loop are removed and purified, in two demineralizers containing about 2 cu ft of resin. As a contamination safeguard, the resin and the demineralizer unit containing it will be periodically removed and discarded.

When the water leaves the demineralizers, it contains no more than 0.5 ppm of total solids. After passing through a micrometallic filter, it enters a 5000 gal stainless steel primary-water tank for recirculation to the primary loop.

Shielding

The primary shield is a 156-in. diameter steel tank filled with water and containing eight concentric steel cylinders. Each cylinder is 2 in. thick and the cylinders are separated by a 1-in. layer of water. The innermost cylinder also functions as the inner wall of the tank and as a support for the pressure vessel.

An iron water shield was selected because it weighs less, is smaller than an equivalent concrete shield, and permits faster fabrication on the site.

The secondary shield—5 ft of concrete—was designed so that the dose rate will be less than 1.5 mr per hour at any point outside the vapor container at building level. This dose rate is much less than allowable laboratory tolerance. Two feet of the secondary-

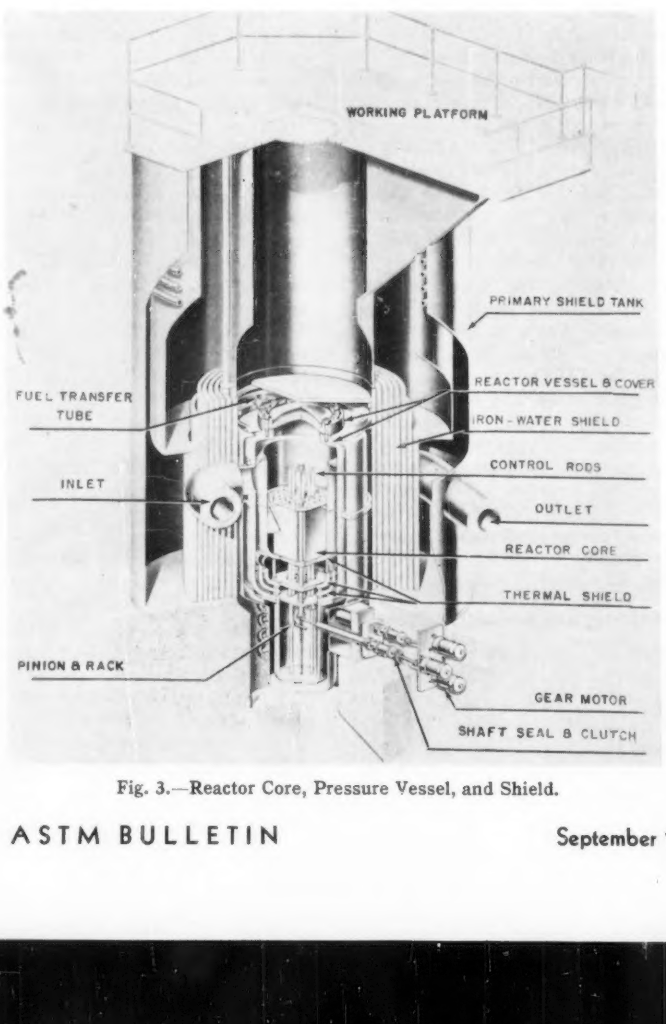


Fig. 3.—Reactor Core, Pressure Vessel, and Shield.

shield concrete are inside the vapor container wall with an additional 3 ft on the outside of the container shell from ground level to a height equal to that of the control room roof.

Vapor Container

The vapor container, which houses the primary system and the steam generator, is a combination steel and concrete structure 32 ft inside diameter and 64 ft high. It was fabricated from $\frac{7}{8}$-in. thick steel ring segments, and has both spherical ends and cylindrical section lined with 2 ft of reinforced concrete.

The inner surface of the 2-ft-thick concrete shield is lined with a light steel plate shell which prevents contamination of the concrete liner and facilitates cleaning in the event of an accident.

A Hagan three-element regulating valve is provided in the feedwater connection to the steam generator. Close regulation of conditions in the steam generator and the secondary system in general is maintained by adjusting the blow-down.

The steam from the steam generator is channeled to the turbine, which has a maximum capability of 2500 kw. The turbine drives a 2500-kva generator through a reduction gear at a speed of 1200 rpm. The generator produces three-phase, 60-cycle current at 4160 v. Excitation is from a 15-kw direct-connected exciter.

This turbine-generator set is capable of converting the total available normal heat output of the steam generator to electric power.

The Lummus condenser has a two-pass, divided water box, single tube-sheet arrangement. Tubes are sealed to the tube sheet with 50/50 solder and then rolled into serrated tube-sheet holes. Serration provides exceptional joint strength, as well as a labyrinth seal between tubes and tube sheet, to prevent leakage of circulating water into the secondary system.

The feedwater heater, located in the secondary system between the condenser and the steam generator, is a normal feature of any efficient steam cycle. It is used to increase the temperature of the feedwater going to the steam generator to approximately that of the saturation temperature.

The APPR uses one low-pressure ALCO feedwater heater operating at system design of 29.9 psia. The effect of the heater is to produce a higher thermal efficiency in the cycle. Heat is channeled to the feedwater heater from a steam-bleed point in the turbine.

Control

The strong negative temperature coefficient of the APPR makes it a very stable system. The instrumentation and controls were designed to take full advantage of this stability.

With the temperature coefficient at least -2×10^{-4} per deg Fahr, no additional control mechanism is needed to override rapid transients or power excursions.

Process controls in the plant are similar to those used in a conventional steampower installation. They consist of instrumentation associated with such system parameters as flows, temperatures, pressures, liquid levels, conductivities, etc., in various ramifications.

Startup of the APPR is manually controlled in coordination with indications from electronic pulse-counting channels. Two instrument channels monitor the neutron flux from the source level to an intermediate range of power to insure safety in startup. Detectors in these channels are the boron-trifluoride and fission chamber types. Compensated ionization chambers serve as the detecting elements for neutron flux covering power levels from intermediate range to 150 per cent of rated plant power. Three identical ion-chamber channels are provided in the safety circuit. These have the main function of "scramming" the reactor if the power should reach unsafe levels.

Scramming is accomplished by release clutches holding the control rods out of the reactor core during operation. The clutches are released electronically, and very rapidly, in response to high neutron flux level, and the rods drop by gravity, thereby inserting the boron poison that shuts down the reactor.

Two of the three safety channels must agree that scramming is required to preclude a "scram-happy" condition of operation. This is called a "coincident" circuit.

A final, period channel is provided to prevent dangerous runaways. This channel, instead of merely responding to the absolute power level or neutron flux, responds to the rate of increase of power level and scrams the reactor when that rate reaches abnormally high values.

Book Form Proposed for Older Portions of X-Ray Powder Data File

THE MAIN topic of discussion at the July meeting in Montreal of the Joint Committee on Chemical Analysis by Powder Diffraction Methods was a proposal to reissue the older portions of the data cards in a book form, and to continue issuing new sets in card form.

Many visitors from North America and abroad entered the discussions, since the meeting was held during the Congress of the International Union of Crystallography. Other countries represented by visitors at the Joint Committee meeting included the Netherlands, Wales, England, Norway, and Spain.

Members of the Joint Committee were entertained at lunch on July 12 in a French Canadian inn on the Richelieu River by Canadian Industries, Ltd., after a trip through the C. I. L. Central Research Laboratories in McMasterville in the morning. A demonstration was provided of the use of the card file of X-ray powder data by the laboratory personnel.

The total of approximately 7500 cards in the complete seven sets is approaching the point of becoming somewhat unwieldy. Also many of the cards in the first five sets have been recommended for deletion. To make the available data more compact and also to cut down the cost to purchasers, a small group has been appointed to investigate all facets of a proposal to reissue the older data in a book form. This would apply only to the plain cards. Keysort and IBM cards would be continued. A decision must be reached within the next year, since the present stock of cards has been estimated to need replenishing at that time.

The probable publication of the eighth set of data was announced as February or March of 1958. Once again, as in the seventh set, the data will be divided into organic and inorganic parts and these will be available separately.

Support was given to the assignment of an absolute intensity value to each pattern, even if only approximate. This would provide an idea of the relative strength of the entire pattern referred to some standard material. The technical subcommittee will discuss this proposal during the coming year.

Numerous requests have been received as to the proper procedure for submitting data to be included in this card file. Any data submitted will be reviewed by the editorial board before being processed and printed. Large blank cards for filling in data on a standard form are available from A. S. Beward, Assistant Editor, Room 107, Osmond Laboratory, The Pennsylvania State College, University Park, Pa.

SEPTEMBER 1957

ASTM Bulletin

NO. 224

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

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OFFERS OF PAPERS FOR 1958

THE Administrative Committee on Papers and Publications will meet in early February to consider the papers to be published by the Society in 1958 and to develop the program for the Annual Meeting to be held in Boston June 22–28.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 10, 1958.*

All offers should be accompanied by a summary which will make clear the intended scope of the paper and will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

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Philadelphia Letter and Mailing Company Serves Society for 47 Years

PERHAPS this news item should have been written seven years ago or three hence when the Commonwealth Addressing and Multigraphing Co. would have served the Society for either forty or fifty consecutive years. Nevertheless there is no reason to withhold such an article, in the belief that our members might like to know of this remarkable record.

George M. Dauphinee, general manager and owner of the Commonwealth Addressing and Multigraphing Co. made his first contacts with the Society's first Executive Secretary, Prof. Edgar Marburg, at the ASTM's University of Pennsylvania offices about 1911. At that time he began serving the Society in multigraphing and mailing work which has continued and expanded to this date. Commonwealth, as the company is known here, sends out virtually all letter mailings to the membership, duplicates in various forms large numbers of letters to the members and others, handles many of our addressing lists, and in the aggregate sends out hundreds of thousands of separate ASTM mailing pieces every year.

George M. Dauphinee

The company is almost a branch office of the Society and Mr. Dauphinee and his capable assistants are thoroughly acquainted with ASTM's operations. Our business relationships are efficient ones, and, of course, down through the years a number of personal relationships have grown up.

Following Professor Marburg's death in 1918, C. L. Warwick, his assistant at the University, succeeded to the position of Executive Secretary-Treasurer and worked closely with Mr. Dauphinee, a cooperation which has continued with the present Executive Secretary, R. J. Painter, from the date he joined the Staff in 1931.

The Commonwealth Co. has grown greatly since its start in 1907 and is now able to handle almost an unlimited volume of work. Mr. Dauphinee has said "All in all it has been a very pleasant relationship and a great honor to have served your Society during all these years." We reciprocate these friendly feelings.

Next Month . . .

In the October BULLETIN, a survey of the Society's huge 1957–58 technical publication program—what is to come and approximately when.

Wood and Metal-Bonding Adhesive Groups in Committee D-14

ASTM Committee D-14 on Adhesives has formed two new subcommittees on end-use applications for adhesives: Wood Adhesives and Structural Metal-Bonding Adhesives such as are of particular current importance in the aircraft field. These new subcommittees will develop test methods and specifications in their own fields. It is anticipated that other end-use subcommittees will be formed later.

Committee D-14 will meet at the Sheraton Hotel in Philadelphia on October 31 and November 1. All individuals interested in wood or metal-bonding adhesives are particularly invited to attend. Further information on this meeting may be obtained from the Secretary of Committee D-14, John J. Lamb, RCA-Victor, Bldg. 10-6, Camden, N. J.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
Oct. 2-3	Committee C-8 on Refractories	Bedford, Pa. (Bedford Springs Hotel)
Oct. 6-10	Committee D-2 on Petroleum Products and Lubricants	Washington, D. C. (Sheraton Park Hotel)
Oct. 6-10	Joint TAPPI-ASTM Committee on Petroleum Wax	Washington, D. C. (Sheraton Park Hotel)
Oct. 7-10	Committee C-16 on Thermal Insulating Materials	Ottawa, Ontario (Chateau Laurier)
Oct. 9-10	Committee B-5 on Copper and Copper Alloys	Boston, Mass. (Statler Hotel)
Oct. 10-11	Committee E-6 on Methods of Testing Building Constructions	Ottawa, Ontario (National Research Council)
Oct. 10-11	Committee C-20 on Acoustical Materials	Ottawa, Ontario (National Research Council)
Oct. 15-18	Committee D-13 on Textile Materials	New York City (Hotel McAlpin)
Oct. 16-18	Committee B-8 on Electrodeposited Metallic Coatings	Philadelphia, Pa. (Benj. Franklin Hotel)
Oct. 24-25	Committee B-1 on Wires for Electrical Conductors	Washington, D. C. (Sheraton Park Hotel)
Oct. 28-30	Committee C-13 on Concrete Pipe	Chicago, Ill. (Union League Club)
Oct. 30-31	Committee D-10 on Shipping Containers	Atlantic City, N. J. (Claridge Hotel)
Oct. 31	New England District	Boston, Mass.
Oct. 31-Nov. 1	Committee D-14 on Adhesives	Philadelphia, Pa. (Sheraton Hotel)
Nov. 11	Southwest District	Houston, Texas
Nov. 13	Detroit District	Detroit, Mich. (Eng. Soc. Bldg.)
Nov. 14-15	Committee D-15 on Engine Antifreezes	Philadelphia, Pa. (Sheraton Hotel)
Nov. 15	Northern California District	San Francisco, Calif. (Engineers Club)
Nov. 18-20	Committee D-9 on Electrical Insulating Materials	Virginia Beach, Va. (Cavalier Hotel)
Nov. 19	Committee E-11 on Quality of Materials	Society Headquarters
Nov. 20-22	Committee D-20 on Plastics	Virginia Beach, Va. (Cavalier Hotel)
Dec. 2-3	Committee C-1 on Cement	Fortin de las Flores, Mex. (Ruiz Galindo)
Dec. 5-6	Committee C-9 on Concrete and Concrete Aggregates	Fortin de las Flores, Mex. (Ruiz Galindo)
Dec. 5-6	Committee B-9 on Metal Powders and Metal Powder Products	Chicago, Ill. (Drake Hotel)
Dec. 9-13	Committee D-18 on Soils for Engineering Purposes	Mexico City, Mex. (Univ. of Mexico)

Your Committee Officers

A new series—to better acquaint BULLETIN readers with the men whose responsibility it is to direct the indispensable work of the ASTM technical committees.

Committee B-5 on Copper and Copper Alloys, Cast and Wrought

Chairman—G. H. **Harnden,** consultant, Engineering Standards Service, General Electric Co.

First Vice-Chairman—W. D. France, in charge of Technical Service Dept., Scovill Manufacturing Co.

Second Vice-Chairman—William Romanoff, vice-president and technical superintendent, H. Kramer & Co.

Secretary—L. H. Adam materials engineer, Frankford Arsenal

Committee B-8 on Electrodeposited Metallic Coatings

Chairman—**C. H. Sample,** The International Nickel Co.

Vice-Chairman—**R. B. Saltonstall,** technical director, The Udylite Corp.

Secretary—D. M. Bigge, metallurgist, Engineering Div., Chrysler Corp.

Committee C-9 on Concrete and Concrete Aggregates

Chairman—**W. H. Price,** head, Engineering Laboratories, U. S. Bureau of Reclamation

Vice-Chairman—**H. L. Kennedy,** manager, Cement Division, Dewey & Almy Chemical Co.

Secretary—**Bryant Mather,** engineer, concrete research, Waterways Experiment Station

Newest ASTM District Formed in Southwest

Recognizing the growing industrialization of the South and the desire of ASTM members in this area to have a formal organization, a new Southeast District has been authorized by the Board of Directors and is now being organized.

James A. Lee, executive director, Southern Brick and Tile Manufacturers Assn., Atlanta, Ga., has been appointed Chairman *pro tem* of the new district. C. J. McMurry, Rome Cable Corp., Atlanta, is serving as Secretary *pro tem.*

The Southeast District, the 15th ASTM district to be formed, covers the states of Florida, Alabama, Georgia, Mississippi, South Carolina, and part of Tennessee. The entire United States, except for the Rocky Mountain states and the Northwest, are now organized into formal ASTM districts.

The formation of a Southeast District culminates endeavors on the part of local ASTM leaders and ASTM Headquarters covering more than a two-year period. President Kropf expects to visit the district at its first formal meeting.

Mexico City—

Site of First ASTM Committee Meetings in Latin America

For the first time in the history of the Society, ASTM technical committees will meet in a Latin American environment. A joint meeting of Committees C-1 on Cement and C-9 on Concrete and Concrete Aggregates will be held in Mexico City, December 2–6, and independently, though arranged to follow this meeting, Committee D-18 on Soils for Engineering Purposes will convene in the Mexican capital, December 9–12. The soils meeting will be held in conjunction with a series of technical sessions sponsored by the Mexican Society of Soil Mechanics and Committee D-18.

Soils Meeting Features Papers Program

Mexico City and the surrounding area have presented outstanding examples, as well as problems, in foundations for buildings. Recently, earthquakes in this area gained the headlines in newspapers, emphasizing the conditions which exist and require consideration in the construction of buildings. The area has always been an interesting one for the student of soil mechanics because of the unusual soil conditions. ASTM Committee D-18 on Soils for Engineering Purposes has arranged a very interesting program of papers, as well as a meeting of the committee, in Mexico City from December 9 to 12. The meetings have been arranged jointly with the Mexican Society of Soil Mechanics, and will be held in facilities provided at the University of Mexico.

Five half-day sessions are planned, consisting of from three to four papers each. These papers will be distributed equally between Mexican and American authors. The general topics to be covered by the papers will include sampling equipment, consolidation, compaction and compaction control, soil strength, and miscellaneous subjects. The preliminary list of papers to be presented is as follows:

- New Developments in Soil Sampling and Rock Coring Equipment—*T. W. Van Zelst*
- Consolidation of Mexico City Volcanic Clay—*L. Zeevaert*
- Laboratory Consolidation Tests for Expansive Clays—*R. F. Dawson*
- Soil Deformations Under Repeated Stress Applications—*H. B. Seed and R. L. McNeill*
- Some Factors Affecting the Dynamic Compaction Test—*E. Tamez*
- Compaction Characteristics of Gravelly Soils—*W. G. Holtz and C. A. Lowitz*
- Effect of Lift Thickness and Tire Pressure on Compaction of Soil with Heavy Roller Tire Rollers—*W. J. Turnbull and C. R. Foster*
- A Rapid Method of Construction Control for Embankments of Cohesive Soils—*J. W. Hilf*
- The Investigation of a Volcanic Soil for the Construction of an Earth Dam—*E. Rios-Lazcano*
- Underpinning and Straightening of an Eleven Story Building in Mexico City—*W. Streu*
- Application of Light - Distribution Analogy to the Computation of Vertical Stresses in a Soil Mass—*H. M. Calderon*
- Sinusoidal Surface Waves in Stratified Soils—*J. J. Slade*
- Investigation by Radioactive Isotopes of Percolating Water Eroding Approaches of a Channel Bridge—*I. Sains-Ortiz*
- Unconfined Compression and Vane Shear Tests in Volcanic Lacustrine Clays—*R. J. Marsal*
- Strength of Saturated Soils Subject to Transient Loadings—*R. V. Whitman*
- Correlation of the California Bearing Ratio with the Iowa Bearing Value—*D. T. Davidson*

This being the first meeting of its kind, in which Committee D-18 has participated on an intersociety as well as international basis, the committee is very anxious that there be in attendance a good representation of members, as well as other engineers and technical people from the United States. Included in the program will be an all-day tour of points of interest to soil mechanics in the Valley of Mexico. Arrangements also are being made for a tour of Mexico City, a ladies' program, and other social events.

It is planned to have available for all those who register, a complete set of preprints of all papers in both English and Spanish. The cost of these papers will be included in the registration fee.

Further information about the meeting or local facilities can be had from W. G. Holtz, U. S. Bureau of Reclamation, Denver Federal Center, Denver, Colo., or in Mexico, Juan J. Correa, Sociedad Mexicano de Mecanica de Suelos, Apdo. Postal 8200, Tacuba No. 5., Mexico A, D. F., Mexico.

Cement and Concrete

Portland cement is being produced and used in Mexico in constantly increasing quantities and there are many outstanding examples of concrete construction in that country, as well. The membership of Committees C-1 on Cement and C-9 on Concrete and Concrete Aggregates, international in scope, has long had active representation from Mexico to the south and Canada to the north. In 1955, the two committees met in Montreal, Canada, and have now accepted an invitation to meet in Mexico.

The joint meetings of the two committees which will be held in Fortin de la Flores, Veracruz, Mexico, were arranged by Alton J. Blank, a member of Committee C-1. The meetings of the Cement Committee will be held on December 2 and 3, and those of the Concrete group on December 5 and 6. The intervening day, December 4, has been set aside for the enjoyment of the scenic and technical attractions of the area.

ASTM Wood Pole Research Program

—Progress Report No. 5

The ASTM Technical Advisory Committee on the Wood Pole program, meeting at the Forest Products Laboratory in Madison, Wis., are, left to right: (top row) C. W. Best, W. G. Youngquist, W. D. Keeney, E. C. O. Erickson, L. W. Wood, C. M. Alber; (middle row) E. C. Kelch, J. O. Blew, G. J. Fister, C. H. Amadon, J. H. Rixse, D. E. Kennedy, A. W. Dohr; (bottom row) L. J. Markwardt, L. G. Smith, R. H. Bescher, G. Q. Lumsden, and R. P. A. Johnson.

***Editor's Note.*—This report is the fifth of a series covering the comprehensive testing program being conducted at the Forest Products Laboratory under the sponsorship of Committee D-7 on Wood. The previous reports have been published in the ASTM BULLETIN and copies may be obtained upon request.**

THE ASTM Wood Pole Research Program is now in its third year. The testing and report work are progressing rapidly. With the encouraging financial support received and the continuing active prosecution of the project, it is now possible to anticipate the completion of the over-all program as presently outlined in about another year.

The purpose and scope of the program were reviewed in detail in the fourth progress report. Broadly, the study includes tests of poles of Southern yellow pine, Western redcedar, lodgepole pine, Douglasfir, and western larch, both in the white and treated, and tests of small clear specimens matched to the pole material. In all, this represents tests of some 600 full-size poles and 15,000 small clear specimens.

The total cost of the research program as presently outlined is estimated at about $254,000. The work is supported by contributions from various interested organizations and agencies, and is being conducted by the ASTM with the cooperation of the U. S. Forest Products Laboratory.

In March of 1957 the Technical Advisory Committee, responsible for directing details of the program, met at the Forest Products Laboratory in a two-day session. Progress to date was reviewed and plans for the remaining work were outlined. Particular consideration was given to the details of the final phases of the program covering research on treated poles, including methods of treatment.

The Canadian Forest Products Laboratory has been associated with the program through its membership in the Society and through its participation in the work of Committee D-7 on Wood. As a supplement to the present program, the Canadian Forest Products Laboratory is planning to conduct additional tests on western redcedar with the thought of broadening the scope of the sampling for this species by testing material selected from Canadian forests. This supplementary work will be integrated with the current program in such a way that the results will be directly comparable.

Wood Pole Symposium

A related development during the past year was the holding of a Symposium on Wood Poles at the time of the ASTM Second Pacific Area National Meeting at Los Angeles in September 1956. The arrangement for the symposium on the West Coast was particularly appropriate in recognition of the extensive production of poles in western United States and their extensive use in that area. It comprised an integrated series of papers covering such subject matter as the function and utility of poles, the potential of pole timber supply, and information relating to the present ASTM program and its implications. The specific papers presented were as follows:

- Wood Poles for Communication Lines, *G. Q. Lumsden*
- A Look Ahead at Wood Pole Production in Relation to the Forest Resource, *E. E. Matson*
- Need for Research on Wood Poles, *L. J. Markwardt*
- Testing Poles for the American Society for Testing Materials, *L. W. Wood*
- Engineering of Specifications for Wood Poles, *L. G. Smith*

Reports

In conducting the research, interim reports, species by species, have been issued, as the results became available without any attempt to analyze the data, on the premise that this could best be done when the complete results for all species on the treated and untreated poles are available. The final report will then present a thorough analysis of all the data including the species relationships, the relation of the strength of small clear specimens to the poles, the effect of preservative treatment, the effect of test methods, and the effect of defects, so far as possible. It will provide a comprehensive technical interpretation of all the data and also the relation of the pole test strength values to the current design values but without recommending the level of fiber stresses

to be used in design. The interim reports are restricted to committee members and contributors, but the final report will be published and made available for wide general distribution.

The program is expected to provide more precise information that will reduce the ignorance factor in pole design and pole safety, provide more accurate means of rating poles for strength, and establish methods of more quickly and economically assigning design values for new pole species. Anticipated yearly savings to pole users will amount to many times the cost of the program. The results of the wood pole research program will be particularly pertinent to the work of Sectional Committee 05 of the American Standards Assn. which is concerned with American Standard Specifications and Dimensions for Wood Poles. A meeting of Sectional Committee 05 was held in November to lay the groundwork for the potential revision of present ASA standards on wood poles in anticipation of the results to be obtained in the ASTM program.

Details of Progress

All of the tests on untreated poles of the five species have been completed and interim reports distributed. Of the five reports issued, the last two in this series were on untreated lodgepole pine and untreated western redcedar poles. A sixth report, comparing the results obtained by the crib test method with those by the machine method, is being reviewed in the light of data obtained on the treated southern pine poles. This report will be completed and distributed during the current year.

The last major phase of the research program covers the tests of treated poles of the five species and the related tests of small clear specimens. In the selection of the poles of the several species to be tested in the treated condition, particular care was used to obtain material in the proper density range representative of the species and corresponding to the density pattern of the untreated poles previously tested. This procedure was established to permit comparison of the results of the treated and untreated material. As to methods of treatment, the details followed good commercial practice for the different species, as reviewed and approved by the committee.

As a further effort to insure proper consideration to the selection of the lodgepole pine poles for treatment, a special meeting attended by representatives of the major producers, Forest Service representatives, and committee members, was held at Madison, Wis. The results of a specific gravity survey of poles by the Western Electric Co. from all major producing areas were reviewed and the results of the previous tests on untreated poles were discussed. The group endorsed the selection plan of the Technical Advisory Committee, and lodgepole pine poles were accordingly procured at Walden, Colo. and Bozeman, Mont.

Tests of the treated southern pine and Douglas fir poles have been completed, and interim reports on this work are in preparation. Western larch poles were selected at Libby, Mont., late in 1956, were treated green, and then forwarded to Madison. Tests of the treated western larch poles are now under way, and the treated lodgepole pine poles are on hand at the Laboratory awaiting test. The western redcedar poles to be treated have been collected and are now in seasoning prior to treatment and shipment to the Laboratory later this year.

Financial Report

Substantial contributions to the program have continued. Receipts at the termination of the ASTM fiscal year as of November 30, 1956 were $222,470, and disbursements as of January 31, 1957 were $186,608.

On the basis of the indicated estimated cost of the presently outlined program of $254,000, additional funds of about $31,000 are needed to reach the budget total. Some additional funds have since been received, but further contributions are invited to assure satisfactory completion of the work.

Since extensive testing work on treated poles will be under way at periods throughout the year, a cordial invitation is again extended to committee members, cooperators, and others interested in poles to visit the Forest Products Laboratory at Madison, Wis., to witness the tests. Since the testing schedule is somewhat intermittent, it is suggested that advance inquiry be made to insure that testing will be in progress at the time of the visit.

L. J. Markwardt, Chairman
Committee D-7 on Wood

AtomFair

The Atomic Industrial Forum is sponsoring an "AtomFair" in conjunction with concurrent meetings of the AIF and the American Nuclear Society at the Coliseum in New York, October 28–31, 1957. Complimentary AtomFair tickets may be obtained by ASTM members on request from the Atomic Industrial Forum. Requests on business letterhead should be addressed to AtomFair, 3 E. 54th St., New York 22, N. Y.

ASTM Meetings in Canada

The National Research Council of Canada will be host to three ASTM technical committees during the week of October 7. The particular occasion for these meetings is the inspection of new and expanded facilities of the NRC Montreal Road Laboratories and Building Research Center in Ottawa. The new facilities will establish the NRC Division of Building Research as one of the best equipped testing centers in the field of building materials and constructions.

Committee C-16 on Thermal Insulating Materials will hold its usual fall meeting October 7–10. Committees C-20 on Acoustical Materials and E-6 on Methods of Testing Building Constructions will meet on October 10 and 11.

During the afternoon of October 10, a general open session is planned with a program of technical papers. The combined group will be welcomed by President E. W. R. Stacie of the National Research Council of Canada. Following the session, there will be an inspection of the Montreal Road Laboratories and the Building Research Center. A dinner for the combined committees is scheduled for the evening of October 10, with an interesting nontechnical speaker.

Announcement of these meetings has been distributed to all members of the Society in Canada, and the meetings will be open to them, as well as to all other interested ASTM members.

Work on Wood Flour Standards Begins

Among the ever expanding by-products of utilization of wood, is the material known as wood flour. This product of wood processing plants is used as an organic filler in such products as floor tile, linoleum, and other compositions. An interest has been expressed in the development of ASTM standards for methods of tests, as well as specifications, on this material.

At a conference held on June 17, in Atlantic City, it was recommended that a subcommittee on wood flour be formed in Committee D-7 on Wood.

While various characteristics of wood flour will be studied, the most important one is the measurement of particle size. There is presently no agreement within the industry as to methods of analysis, and there is great need to establish standard procedures which will be reproducible throughout the industry.

H. W. Shader, Armstrong Cork Co., Lancaster, Pa., will serve as chairman of the subcommittee. All interested persons are urged to communicate with him.

New SBR and SBR Latex Numbers

Assignments by Committee D-11 on Rubber Products

New numbers have been assigned by ASTM Committee D-11 on Rubber and Rubber-Like Materials to five styrene and butadiene rubbers (SBR) and three new SBR latices which have been brought on the market during the past several months. The assignment of these numbers to new polymers is in accordance with a procedure established by Committee D-11 authorizing a special committee to make such assignments. The membership of this special-committee comprises: B. S. Garvey, Pennsalt Chemicals Corp., chairman of Subcommittee XIII on Synthetic Elastomers; I. D. Patterson, Goodyear Tire and Rubber Co., and F. J. Sackfield, American Synthetic Rubber Corp.

Requests for assignments of new numbers should be made following the practices now recommended in the ASTM Recommended Practice for Description of Types of Styrene Rubbers (SBR) (D 1419) and Recommended Practice for Description of Types of Styrene Rubber (SBR) and Butadiene Rubber (BR) Latices (D 1420).

While the numbers were assigned at the request of the companies indicated, any producer who wishes to make a product corresponding to the descriptions given may use the same numbers for his product.

These and subsequent new numbers as assigned will be published in the ASTM Bulletin and in the *Rubber World* and *Rubber Age* periodicals for the benefit of industry. Once each year the new numbers and descriptions will be incorporated in ASTM Recommended Practices D 1419 and D 1420 by appropriate action of Committee D-11 and of the Society.

This assignment of code numbers has been found desirable since the code numbers for the various types of rubbers and latices lost their status and validity after the Government's synthetic rubber plants were sold to private corporations in 1955.

The new numbers and the corresponding product descriptions are shown in the accompanying Tables I and II.

TABLE I—DESCRIPTION OF TYPES OF NEW STYRENE-BUTADIENE RUBBERS (SBR)—ASSIGNMENT OF NEW CODE NUMBERS—ASTM D 1419-56 T.

Number assigned	1605	1773	1778	1803	1812
Date assigned	5/1/57	5/1/57	5/1/57	5/1/57	5/1/57
Requested by	Phillips	Goodyear	Goodyear	Phillips	Phillips
Distinctive feature	FEF Blk MB	NST Naph Oil MB	NST Naph Oil MB	HAF Blk HI-AR Oil MB	ISAF Blk-HI-AR Oil MB
Close previous number, if any	....	1703	1707, 1708	....	....
Type	Cold Blk MB	Cold Oil MB	Cold Oil MB	Cold Oil-Blk MB	Cold Oil-Blk MB
Nominal Temp, deg Fahr.	43	43	43	43	43
Activator	FRA	FRA	FRA	FRA	FRA
Shortstop	ND	ND	ND	ND	ND
Antioxidant	NST	NST	NST	ST	ST
Catalyst	OHP	OHP	OHP	OHP	OHP
Emulsifier	FA	Mixed	Mixed	Mixed	Mixed
Nominal bound styrene, per cent	23 5	23.5	23.5	23.5	23.5
Nominal conversion, per cent	60	60	60	60	60
Nominal Mooney viscosity, ML 1 + 4(212 F), polymer	....	60	55	....	....
Nominal Mooney Viscosity ML 1 + 4(212F), compound	62	....	....	65	57
Coagulation	GA	SA	SA	SA	SA
Carbon black, type	FEF	....	....	HAF	ISAF
Carbon black, per cent	33.3	....	....	28.6	26.7
Oil, Type	....	NST-NAPH	NST-NAPH	HI-AR	HI-AR
Oil, Parts	....	25	37.5	25	37.5
Finishing	Normal	Normal	Normal	Normal	Normal

Note: Abbreviations and symbols are defined as follows:

AC-AL = Acid alum
AR = Aromatic
BR-AL = Brine-alum
D = Discoloring
FA = Fatty acid
FRA = Free radical type, *i.e.*, iron-pyrophosphate, peroxamine sulfoxylate
GA = Glue acid
HI-AR = Highly aromatic
MB = Masterbatch
NAPH = Naphthenic
ND = Non-discoloring
NST = Non-staining
OHP = Organic hydroperoxide
P = Persulfate
RA = Rosin acid
SA = Salt-acid
SL ST = Slightly staining
ST = Staining
SP = Special finishing

TABLE II—DESCRIPTION OF TYPES OF NEW STYRENE-BUTADIENE RUBBER (SBR) AND BUTADIENE RUBBER (BR) LATICES—ASSIGNMENT OF NEW CODE NUMBERS—ASTM D 1420-56 T.

Number assigned	2110	2111	2112
Date assigned	5/29/57	5/29/57	5/29/57
Requested by	Copolymer Rubber & Chemical Corp.		
Distinctive feature	FA Emulsifier—60% Solids	RA Emulsifier—20% Solids	RA Emulsifier—40% Solids
Close Previous Number, if any	...	...	...
Type	High Solids-Cold SBR Latex	Low Solids-Cold SBR Latex	Low Solids-Cold SBR Latex
Nominal temp., deg Fahr.	50	50	50
Activator	FRA	FRA	FRA
Shortstop	ND	ND	ND
Catalyst	OHP	OHP	OHP
Emulsifier	FA	RA	RA
Nominal conversion, per cent	60	60	60
Nominal Mooney viscosity, ML 1 + 5 (212F), polymer	...	52	52
Nominal residual volatile unsaturate, per cent	0.10	0.10	0.10
Nominal pH value	9.5	9.5	9.5
Nominal surface tension, dynes per cm	...	...	...
Nominal coagulum on No. 80 sieve, per cent	0.10	0.10	0.10
Nominal bound styrene, per cent	25	23.5	23.5
Nominal total solids, per cent	60	20	40

Note: Abbreviations and symbols are defined as follows:

FA = Fatty acid
FRA = Free radical type
ND = Non-discoloring
OHP = Organic hydro peroxide
P = Persulfate
RA = Rosin acid

Random Samples...

FROM THE CURRENT MATERIALS NEWS

From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream, or address Random Samples, ASTM, 1916 Race St., Philadelphia 3, Pa.

Rubber Roads Abroad Testing Out Well

A. F. W. WILDEBOER, European road expert and former road consultant to Rubber-Stichting, Delft, has recently completed a survey of European rubber roads. His report, in the current issue of *Rubber Developments*, highlights the success of these experiments.

The author reviewed roads in Holland, Germany, Switzerland, Austria, Denmark, Sweden, and Finland. In the main, stretches using rubber outlasted control stretches without rubber.

He notes for example that on the outskirts of Bussum, on the main road through Leeuwarden, and near Schiphol (all in Holland) are three separate stretches about 20 years old. Each was still in excellent condition whereas adjacent nonrubber control stretches have had many times the additional initial cost spent on them in repairs.

Referring to Germany, the writer points out that stretches of rubber asphalt surfacing on roads, pontoons, and warehouse floorings in Frankfurt, Cologne, and Hamburg "are showing definitely better." One of the roads that impressed him most was a stretch on the arterial highway near Oberhausen in the Ruhr "which is now three years old and shows a tremendous difference." In Frankfurt, between 1951 and 1952, 28 test stretches were laid over cobble pavements. Only one of these was rubberized. To date, this is the only one still in perfect condition.

The author was equally impressed with rubber road stretches in other countries. Looking for an answer to the superior showing of rubber and asphalt, Wildeboer points out that samples extracted from the road "have shown really remarkable improvement in stability at high temperatures (40 C) over the same mixtures without rubber (up to 200 per cent)."

He also says, "The impact resistance at 0 C shows also an improvement between 55 and 20 per cent. This is all due to the better cohesion in the bitumen and the lower heat sensitiveness of rubberized bitumens."

There is also "a really astonishing difference in aging in favor of rubber." Wildeboer thinks that this may be due to the "result of molecular rearrangement due to temperature changes, especially in thin layers where the rubber prevents the bitumen from hardening."

It is this difference in aging, the author believes, that explains why the other improvements in the properties of the binding medium are retained so much better and keep the road in its original laying condition much longer, thereby extending its total life considerably.

Wildeboer's full comments appear in an illustrated article in the current issue of *Rubber Developments*. For a free copy, write the Natural Rubber Bureau, 1631 K St., N. W., Washington 6, D. C.

Pyrogenics

THE WORD pyrogenics denotes research in the uncharted area of high temperatures. A prime objective is to study the behavior of materials at temperatures up to those in the sun; earlier attempts have been limited not only by the materials themselves but by means to generate and concentrate enough heat. Within the past few years, however, new equipment has become available, and the feasible range now extends to almost 1,000,000 deg absolute.

When heated to high temperatures, materials tend to become contaminated by the container surrounding them; for example, when metals are heated in graphite crucibles, they react with the container wall to form carbides, which then pass into solution in the metal. Moreover, many materials, near their melting point, react with oxygen or other constituents of the atmosphere; to avoid this, tests have to be carried out in a vacuum or with some inert gas. Various techniques for heating materials have been devised to overcome these difficulties. For example, metals can be heated directly by forming an electric arc between the metal and a tungsten electrode; this approach is particularly useful for the continuous melting of metal powders.

An elegant method of heating metals without a crucible is by levitation. The metal is both heated and suspended in space by an electromagnetic field, generated by a high-frequency current flowing through two separated spiral coils. Another method is the drop-by-drop fusion of compressed, powdered metal which is gradually pushed into the electromagnetic field inside a coil having a high-frequency current passing through it. Induction furnaces using graphite have been used to produce temperatures up to 3600 C, although in this case the problem of graphite vapors contaminating the material is serious.

All these methods have the disadvantage that complex apparatus is required to heat the test material, and usually they are suitable only for materials that are electrical conductors. A far more promising approach is to focus radiant energy with an optical system; a free and generally available energy source is the sun.

The surface of the sun has a temperature of around 6000 deg absolute, and even with an inefficient optical system, temperatures in excess of 3000 C can be reached in a solar furnace. Focusing of the sun's rays to give high temperatures over a limited area satisfies the requirement that no container be used since the test material itself forms the container. Also, since radiation is "pure heat," contamination by furnace walls and vapors is avoided, and the test material is not exposed to any significant electric and magnetic fields, which for certain investigations are definite drawbacks. Because of these various advantages, more than twenty different solar furnaces have been completed or are being built in various research laboratories in the United States, and it is now even

possible to buy a solar furnace as a finished piece of research equipment.

High-intensity electric arcs offer a promising alternative to the use of the sun. Such arcs, combined with a suitable optical system, could heat a sample 1000 C higher than the temperature obtained with the sun as a source of radiation. The advantage is that experiments can be conducted indoors and do not depend upon the vagaries of the weather. High temperature flames go up to 6000 C, but flames do not readily yield much high-temperature radiation, and are not useful as sources for an optical system.

Although means for generating high temperatures are now available, experimental results reported in the literature are as yet rather meager. It is known that, in the higher temperature range, materials change their properties radically, but considerable work must be done before scientists will be able to formulate even broad concepts covering the high-temperature state.

Above 3500 C, elemental solids do not exist, and the upper limit for elemental liquids is 5900 C. To go higher on the temperature scale, therefore, materials must be handled in the gaseous state, and normal heat transfer methods are not satisfactory. The physical behavior of gases must be studied through phenomena that last only a few minutes, and the necessary instrumentation is very complex. Moreover, even using arcs that are stabilized with water or air jets, to achieve more even performance, physical equipment is eroded by the high-temperature high-velocity gas. Using this approach, however, research workers expect to exceed even the stringent conditions met during high-velocity flight, and to complete basic studies of the chemistry and physics of materials when they approach the gaseous state.

Industrial Bulletin, Arthur D. Little, Inc., April, 1957.

Tapa Cloth

An old Polynesian cloth shows how versatile a nonwoven fabric can be. The tapa of Hawaii, a material made from the bark of the paper mulberry plant, displays the greatest variety of texture, color, and design found anywhere in the Pacific islands. Now only a museum curiosity, it was used primarily for garments such as loin cloths, skirts, and shawls; technical-economic obsolescence, in the form of missionary-supplied calico, was responsible for its demise.

Tapa was made in four stages, by alternately beating, and drying and bleaching the mulberry bark. Tapa beaters were clubs about 15 in. long, made of hard wood, that weighed about $1\frac{1}{2}$ lb; their surfaces varied with each step in manufacture. As anvils, the Hawaiians used a water-worn boulder for the first beating and a squared log about $5\frac{1}{2}$ ft long for the second. The blows on the wooden anvil could be heard at considerable distance, and the women tapa-makers could relay messages around the island while they were working.

Peeled from shoots about 10 ft long and 1 in. thick, the mulberry bark was first trimmed and separated into its inner and outer layers. The clean strips of inner bark, called bast, were folded, put into bowls, covered with sea water, and left for a week to soften. Using a sharply grooved blade to break up the fibers, the women beat the soaked bast into long, wide strips which were then dried and bleached in the sun. The dried strips were again soaked in water, and rolled in bundles corresponding to the size of cloth desired. Finally, they were set out in a drying yard, covered with banana leaves, and left for a week to mature.

For the second beating, a club with four different surfaces was required. A grooved surface was used first to break up the fibers; then the mass was beaten with a finer surface to felt the material together. Next, the craftswoman used a surface carved with linear or geometric designs to impress a pattern on the cloth—a feature unique to Hawaiian tapa—and finally an even blade for smoothing. In the last stage, the material was spread over moss in water and exposed to the night dew, until it was white and shiny like linen.

The original Polynesian dyeing process involved simply immersing the white tapa in colored liquid or hand-painting designs on it. In Hawaii, however, where the bast was soaked in dye between the beatings, a favorite technique was to lay a colored piece of tapa over a white one and beat them together, producing a single piece of cloth that was white on one side and colored—usually red—on the other. Another Hawaiian variation was to hold a freshly-dyed cord taut on the white tapa and snap it, a technique which resulted in an intricate pattern of twisted lines. Plants were often placed between sheets of tapa to impart their fragrance to the cloth.

Block printing on tapa, developed by the Hawaiians, occurs nowhere else in Polynesia. The blocks were made out of bamboo, a material of suitable thickness, easy to split and carve. Many designs repeat those of the beaters; a common pattern is similar to a large table fork with considerable variation in the width and arrangement of the prongs. The Bernice P. Bishop Museum in Honolulu has uncovered 340 different beater designs and 262 different tapa stamps.

U.S. consumption of nonwoven fabrics has grown from a few thousand pounds per year in 1945 to over 60 million pounds in 1956, mostly in industrial applications. If the technology could be adapted to present needs, there might be further interest in tapa cloth—probably the first nonwoven fabric.

Industrial Bulletin, Arthur D. Little, Inc., May, 1957.

Rubber and Plastics in F(l)ight

Current demands on plastics and rubber in aircraft and missiles are close to the ultimate capabilities of the materials and a major break-through is necessary to meet requirements of the near future. This view was expressed by members of a rubber and plastics symposium of the National Security Industrial Assn. in Washington.

Today's materials are hard put to meet present demands in aircraft and missiles and fall far short of requirements expected by models now on the drawing boards, not to mention those still in the study stage. By next year, plastics and rubber components must withstand temperature extremes from −450 F to 1500 F, perform satisfactorily at altitudes of 250,000 ft in an environment of ozone, ultraviolet radiation, cosmic radiation, and reduced pressure. In addition, they will come in contact with exotic fuels; synthetic lubricating oils, hydraulic fluids; special fluids, such as liquid oxidizers, and will be exposed to nuclear radiation.

Today's materials literally are straining to meet temperature limits of from 100 to 600 F and altitudes of 80,000 ft with ozone and low-pressure problems.

To solve future needs much can be gained from work already under way on the development of new polymeric materials. Study of metallo-organic compounds, inorganic polymers, fluorinated polymers, and others would lead to the breakthrough.

Assignments in Defense Standardization Program

WITH THE assignment of responsibility for standards work in the Defense Stancardization Program, another important step has been taken in the vital coordination activities that have been under way for many months. The ASTM BULLETIN has carried from time to time notes on the Defense Standardization Program which is spark-plugged by the Standards Division of the Department of Defense. John Dunn is the Head of the Standards Division. All of this work clears through the Assistant Secretary of Defense for Supply and Logistics, Perkin McGuire.

With so many branches of the Government concerned with a wide variety of products and materials, much time has been devoted to selecting the Military Department most logical to be responsible for each of the classes listed in the Federal Specifications Catalog. This catalog lineup has been followed in making assignments. In almost every case, in addition to the assignee, a participating activity has been listed.

With these assignments, a total of 510 Class Assignments have been made, and as of March 27, additional classes had not yet been assigned.

It should be made clear that simply because these assignments have been made does not mean that the department responsible is immediately intensifying the work on new or revised Federal standards. Considerable machinery may need to be set up, but it is expected that a great deal of overlap of effort will be eliminated, and certainly industry and particularly organizations anxious to help in coordinating federal and industry standards, will be in a better position with responsibilities clearly designated, to assist.

The assignments list is so extensive that it is not feasible to reprint it in the BULLETIN, but selections of interest to ASTM members appear in the accompanying columns.

Anyone interested in determining standards responsibility can write the Standards Division, Department of Defense, Washington 25, D. C. This latest list is based on the Directory as of March 15, 1957.

CONSOLIDATED LIST OF STANDARDIZATION RESPONSIBILITY AMONG THE MILITARY DEPARTMENTS BY ASSIGNEE ACTIVITY AND BY PARTICIPATING ACTIVITY

Responsible Branch	Class	Title	Assignee Activity	Participating Activity Army	Navy	AF
Mechanical Power Transmission Equipment						
Mech	3030	Belting, Drive Belts, Fan Belts and Accessories	Army-Ord		Ships	TOPEKA
Bearings						
Mech	3110	Bearings, Antifriction, Unmounted	Navy-Ships	Ord		MEMPHIS
Mech	3120	Bearings, Plain, Unmounted	Navy-Ships	Ord		MEMPHIS
Rope, Cable, Chain, and Fittings						
Engr	4010	Chain and Wire Rope	Navy-Ships	TC		TOPEKA
Mat	4020	Fiber Rope, Cordage, and Twine	Navy-Ships	QMC		TOPEKA
Pipe, Tubing, Hose, and Fittings						
Mat (C/Engr)	4710	Pipe and Tube, Metal	AF-TOPEKA	CE	Ships	
Mat (C/Engr)	4720	Hose and Tubing, Flexible	Navy-Ships	ORD		SHELBY
Hardware and Abrasives						
Engr.	5305	Screws	AF-TOPEKA	ORD	Ships	
Engr.	5306	Bolts	AF-TOPEKA	ORD	Ships	
Engr.	5307	Studs	AF-TOPEKA	ORD	Ships	
Engr.	5310	Nuts and Washers	AF-TOPEKA	ORD	Ships	
Engr.	5320	Rivets	AF-TOPEKA	ORD	Aer	
Mat (C/Engr)	5330	Packing and Gasket Materials	Navy-Ships	ORD		TOPEKA
Mat	5335	Metal Screening	Army-CE		Docks	TOPEKA
Mat	5350	Abrasive Materials	Navy-Ships	ORD		TOPEKA
Lumber, Millwork, Plywood, and Veneer						
Mat	5510	Lumber and Related Basic Wood Materials	Army-CE		Ships	TOPEKA
Mat	5530	Plywood and Veneer	Army-CE		Ships	TOPEKA
Construction and Building Materials						
Mat	5610	Mineral Construction Materials, Bulk	Army-CE		Docks	TOPEKA
Mat	5620	Building Glass, Tile, Brick, and Block	Army-CE		Docks	TOPEKA
Mat (C/Engr)	5630	Pipe and Conduit, Nonmetallic	Army-CE		Docks	TOPEKA
Mat	5640	Wallboard, Building Paper, and Thermal Insulation Materials	Army-CE		Docks	TOPEKA
Mat	5650	Roofing and Siding Materials	Army-CE		Docks	TOPEKA
Mat	5660	Fencing, Fences, and Gates	Army-CE		Docks	TOPEKA
Mat	5670	Architectural and Related Metal Products	Army-CE		Docks	TOPEKA
Electrical and Electronic Equipment Components						
E&A	5955	Piezoelectric Crystals	Army-SigC		Ships	GENTILE
E&A	5960	Electron Tubes, Transistors, and Rectifying Crystals	Navy-Ships	SigC		GENTILE
E&A (C/Mat)	5970	Electrical Insulators and Insulating Materials	Navy-Ships	SigC		GENTILE
E&A	5977	Electrical Contact Brushes and Electrodes	Navy-Ships	CE		GENTILE
Electric Wire, and Power and Distribution Equipment						
E&A	6145	Wire and Cable, Electrical	Army-SigC		Ships	ROME
Instruments and Laboratory Equipment						
Mech (C/E&A & Engr.)	6635	Physical Properties Testing Equipment	Army-Ord		NOrd	GENTILE
Mat	6640	Laboratory Equipment and Supplies	Army-CmlC		NOrd	GENTILE
Chemicals and Chemical Products						
Mat	6810	Chemicals[1]	Army-CmlC		Ships	TOPEKA
Mat	6820	Dyes	Army-CmlC		Ships	TOPEKA
Mat	6840	Pest Control Agents and Disinfectants	Navy-Ships	QMC		TOPEKA
Mat	6850	Miscellaneous Chemical Specialties[1]	Army-CmlC		Ships	TOPEKA
Containers, Packaging, and Packing Supplies						
Mat	7930	Cleaning and Polishing Compounds and Preparations[2]	Army-QMC		Ships	TOPEKA

[1] Petroleum and petroleum products in these classes assigned to Aer. See DOD Directive 4115.1 for definition of petroleum and petroleum products.

[2] Petroleum and petroleum products in this class assigned to Ships. See DOD Directive 4115.1 for definition of petroleum and petroleum products.

Brushes, Paints, Sealers, and Adhesives						
Mat	8010	Paints, Dopes, Varnishes, and Related Products[1]	Navy-Ships	CE		TOPEKA
Mat	8030	Preservative and Sealing Compounds[3]	Army-Ord		Ships	TOPEKA
Mat	8040	Adhesives	Navy-Aer	ORD		TOPEKA
Pkg	8105	Bags and Sacks	Army-QMC		S&A	GADSDEN
Pkg	8110	Drums and Cans	Army-QMC		S&A	GADSDEN
Pkg	8115	Boxes, Cartons, and Crates	Navy-S&A	QMC		GADSDEN
Pkg	8125	Bottles and Jars	Navy-BuMed	Med		GADSDEN
Pkg	8135	Packaging and Packing Bulk Materials	AF-GADSDEN	QMC	S&A	
Textiles, Leather, and Furs						
Mat	8305	Textile Fabrics	Army-QMC		S&A & MC	SHELBY
Mat	8310	Yarn and Thread	Army-QMC		S&A & MC	SHELBY
Mat	8315	Notions and Apparel Findings	Army-QMC		S&A & MC	SHELBY
Mat	8320	Padding and Stuffing Materials	Army-QMC		S&A & MC	SHELBY
Mat	8325	Fur Materials	Army-QMC		S&A & MC	SHELBY
Mat	8330	Leather	Army-QMC		S&A & MC	SHELBY
Mat	8335	Shoe Findings and Soling Materials	Army-QMC		S&A & MC	SHELBY
Mat	8340	Tents and Tarpaulins	Army-QMC		S&A & MC	SHELBY
Toiletries						
Mat	8520	Toilet Soap, Shaving Preparations, and Dentrifices	Army-QMC		S&A	SHELBY
Fuels, Lubricants, Oils, and Waxes						
Mat	9110	Fuels, Solid (Subassign to Navy coal used in commercial-industrial facilities or used in central heating plants in furnaces rated at 600,000 BTU/Hour and larger)	Army-CE		Docks	MAAMA
Mat	9120	Fuel Gases	Navy-Docks	CE		MAAMA
Mat	9130	Gasoline and Jet Fuel	Navy-Aer	Ord		MAAMA
Mat	9140	Fuel Oils	Navy-Ships	CE		MAAMA
Mat	9150	Oils and Greases: Cutting, Lubricating, and Hydraulic	Navy-Aer	Ord		MAAMA
Mat	9160	Miscellaneous Waxes, Oils, and Fats	Navy-Ships	QMC		MAAMA
Nonmetallic Fabricated Materials						
Mat	9310	Paper and Paperboard	Army-QMC		Aer	SHELBY
Mat	9320	Rubber Fabricated Materials	Army-Ord		Ships	SHELBY
Mat	9330	Plastic Fabricated Materials	Navy-Ships	SigC		SHELBY
Mat	9340	Glass Fabricated Materials	Army-Ord		Ships	SHELBY
Mat	9350	Refractories and Fire Surfacing Materials	Navy-Ships	CE		SHELBY
Nonmetallic Crude Materials						
Mat	9420	Fibers: Vegetable, Animal, and Synthetic	Navy-Ships	QMC		SHELBY
Mat	9430	Miscellaneous Crude Animal Products, Inedible	Army-QMC		Ships	SHELBY
Mat	9440	Miscellaneous Crude Agricultural and Forestry Products	Army-QMC		Ships	SHELBY
Metal Bars, Sheets, and Shapes						
Mat	9505	Wire, Nonelectrical, Iron and Steel	Navy-NOrd	CE		TOPEKA
Mat	9510	Bars and Rods, Iron and Steel	Army-Ord		Ships	TOPEKA
Mat	9515	Plate, Sheet, and Strip: Iron and Steel	Navy-Ships	Ord		TOPEKA
Mat	9520	Structural Shapes, Iron and Steel	Army-CE		Ships	TOPEKA
Mat	9525	Wire, Nonelectrical, Nonferrous Base Metal	AF-TOPEKA	Ord	Aer	
Mat	9530	Bars and Rods, Nonferrous Base Metal	AF-TOPEKA	Ord	Aer	
Mat	9535	Plate, Sheet, Strip, and Foil: Nonferrous Base Metal	AF-TOPEKA	Ord	Aer	
Mat	9545	Plate, Sheet, Strip, Foil, and Wire: Precious Metal	AF-TOPEKA	QMC	Aer	
Ores, Minerals, and Their Primary Products						
Mat	9620	Minerals, Natural and Synthetic[4]	AF-TOPEKA	CE	Ships	
Mat	9630	Additive Metal Materials and Master Alloys	AF-TOPEKA	Ord	Aer	
Mat	9640	Iron and Steel Primary and Semifinished Products	Army-Ord		NOrd	TOPEKA
Mat	9650	Nonferrous Base Metal Refinery and Intermediate Forms	AF-TOPEKA	Ord	Ships	
Mat	9660	Precious Metals Primary Forms	AF-TOPEKA	QMC	Ships	

List of Abbreviations Used

Standardization Division, OASD (S&L)

E&A —Electronic and Aircraft Branch, SS-3
Engr —Engineering Branch, SS-4
Mat —Materials Branch, SS-5
Mech —Mechanical Equipment Branch, SS-6
Pkg —Packaging Branch, SS-7

Army

CmlC —Chemical Corps
CE —Corps of Engineers
Med —Army Medical Service
Ord —Ordnance Corps
QMC —Quartermaster Corps
SigC —Signal Corps
TC —Transportation Corps

Navy

Aer —Bureau of Aeronautics
MC —Marine Corps
BuMed —Bureau of Medicine & Surgery
NOrd —Bureau of Ordnance
Pers —Bureau of Personnel
CG —Coast Guard
Ships —Bureau of Ships
S&A —Bureau of Supplies & Accounts
Docks —Bureau of Yards & Docks

Air Force

HQ AMC —Air Materiel Command
SMAMA —Sacramento Air Materiel Area
SBAMA —San Bernardino Air Materiel Area
MAAMA —Middletown Air Materiel Area
WRAMA —Warner Robins Air Materiel Area
MOAMA —Mobile Air Materiel Area
OOAMA —Ogden Air Materiel Area
SAAMA —San Antonio Air Materiel Area
OCAMA —Oklahoma City Air Materiel Area
TOPEKA —Topeka Air Force Depot
SHELBY —Shelby Air Force Depot
ROME —Rome Air Force Depot
GADSDEN —Gadsden Air Force Depot
MEMPHIS —Memphis Air Force Depot
GENTILE —Gentile Air Force Station
ARDC —Air Research and Development Command
WADC —Wright Air Development Center

Note: Technical coordination and engineering responsibility is a function of Headquarters, ARDC performed by WADC.

Other

ASMPA —Armed Services Medical Procurement
NSA —National Security Agency

[3] Petroleum and petroleum products in this class assigned to Aer. See DOD Directive 4115.1 for definition of petroleum and petroleum products.

[4] Petroleum and petroleum products in this class assigned to Ships. See DOD Directive 4115.1 for definition of petroletum and petroleum products.

An Apology

E. R. Ballantyne (left) and J. W. Spencer (right), Division of Building Research of the Commonwealth Scientific and Industrial Organization, Highett, Victoria, Australia, are the authors of the paper "Temperatures of Bituminous Roof Surfaces" which appeared on page 69 of the July ASTM BULLETIN.

We deeply regret that the photographs which appeared with the paper, purporting to be Messrs. Ballantyne and Spencer, were in fact Charles E. Stephenson and Anthony H. Willbourn whose paper "The Vicat Softening Point Test for Plastics" appears on page 28 of this issue. Our sincere apologies to the four gentlemen involved in this unfortunate error.

Ninth Conference on Analytical Chemistry and Spectroscopy

THE Analytical Chemistry Group of the Pittsburgh Section of the American Chemical Society and the Spectroscopy Society of Pittsburgh will sponsor the Ninth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy at the Penn-Sheraton Hotel in Pittsburgh, Pa., March 3 to 7, 1958.

Symposia are being planned in the fields of liquid-liquid extraction, electroanalysis, and electron paramagnetic resonance, and papers are invited for consideration for inclusion in the symposia programs as well as papers on all phases of analytical chemistry and instrumental analysis.

Abstract deadlines for symposium papers is October 1; for general papers, the deadline is November 1. Address all correspondence regarding papers to:

E. M. DuBois, Program Chairman
Spectrochemical Laboratories, Inc.
1010 Wood St.
Pittsburgh 21, Pa.

The Bookshelf

Deformation and Flow of Solids

R. Gammel, Ed., Springer-Verlag, Berlin/Gottingen/Heidelberg, 1956.

THIS book contains lectures and important discussion presented at a colloquium held at Madrid, Spain, during the last week of September, 1955. The colloquium was organized by The International Union of Theoretical and Applied Mechanics (IUTAM). The main purpose was to bring together two groups of scientists—solid state physicists and research workers in mechanics—in discussion of the deformation and flow of solids

As might be expected in such a collection, there is a diversity of language and of viewpoint. Of the 27 lectures, more than half are in English, but there are five in German, four in French, and one in Spanish. The six published discussions [illegible] of these languages. Viewpoints of the lecturers range from major interest in mathematical principles to some emphasis on experimental observation, and from discussion of mechanisms on the atomic scale to empirical development of relations from observations of macroscopic phenomena.

Nevertheless, there is evidence of careful planning. The program is arranged under three main headings: (1) Dislocations and Plasticity; (2) Nonlinear Elasticity and Miscellaneous Problems; (3) Viscoelasticity and Relaxation. In the colloquium, two days were allotted for the first topic and one day for each of the other two topics. For each day there were two general lectures which served to set the stage for immediately subsequent presentations. In the following listing of papers, the term "general lectures" refers specifically to those so designated in the schedule of the colloquium.

The first paper in the book is a general lecture by G. I. Taylor that describes the "Strains in Crystalline Aggregate." This paper is followed by two somewhat more specialized ones: "Influence of Intergranular Boundaries on the Strain Hardening of Materials" by B. Jaoul; and "Dislocations and Lattice Theory" by G. Leibfried. Next, a general lecture by A. H. Cottrell on "Dislocations in Crystals" prepares a background for four following papers on more specific aspects of dislocation theory: "Theories of Fracture in Metals" by N. F. Mott; "Dislocations and Brittle Fracture in Metals" by John R. Low, Jr.; "The Origin of Dislocations in Crystals Grown from the Melt" by F. C. Frank; and Magnetoresistivity of Plastically Deformed Metals" by H. G. vanBueren.

The second half of the sessions on dislocations and plasticity is introduced by a general lecture by A. Seeger on "Recent Mathematical Methods and Physical Results in Crystal Plasticity." The three lectures following this are "The Mechanisms of Rupture of Metals" by C. Crussard, J. Plateau, and Y. Morillon; "Wave Propagation in Anelastic Materials" by E. H. Lee; and "The Lamellar Structure of Grain Boundaries in Metals" by F. Teissier du Cros. Another paper, by P. G. Hodge, Jr., presents a discussion of yield criteria and, in a very general framework, a particular approach on "The Theory of Piecewise Linear Isotropic Plasticity." This general lecture was followed by three papers: "A New Theory of Plasticity" by M. Velasco de Pando; "The Theory of Deformation on Nonhardening Rigid-Plastic Plates Under Transverse Load" by H. G. Hopkins; and "Theory of Melting and Yield Strength" by H. Aroeste.

The second main topic on nonlinear elasticity and miscellaneous problems is introduced by H. Kauderer in a general lecture on "A Nonlinear Elasticity Law; Development and Application Possibilities." Then, a short paper is presented by M. Reiner on "Second Order Effects in Infinitesimal Elasticity." Some rather different points of view (for example, that of thermodynamics and a phenomenological approach) are included in the next general lecture on "Large Elastic Deformations in Rubberlike Materials" by L. R. G. Treloar. This section is concluded by two papers: "Physical Effects in Cavitation Damage" by M. S. Plesset; and "Some Applications of the Method of 'Internal Constraints' to Dynamic Problems."

The third main topic concerned viscoelasticity and relaxation. The introductory general lecture is a mathematical discussion of "Variational and Lagrangian Methods in Viscoelasticity" by M. A. Biot. A less mathematical discussion of "Viscosity and Irreversible Deformations" by H. Le Boiteux follows. The last of the general lectures is "Viscosity and Time Effects in the Nonlinear Region" by F. Schultz-Grunow; this paper includes the viewpoint of that part of the mechanics of fluid which is pertinent to solids. Concluding lectures are "The Damage Process in Metals During Creep" by I. A. Oding and W. W. Burdukski; "The Effect of Small Viscous Inclusions on the Mechanical Properties of an Elastic Solid" by J. G. Oldroyd; and "Dislocation Relaxations in Metals and Single Crystals" by W. P. Mason.

As the above listing of titles and authors shows, the book is mainly a collection of informative articles by recognized authorities The articles are primarily concerned with fundamental understanding (and gaps in such understanding) of the mechanics of deformation of solids—particularly polycrystalline metals. The reader should not expect an engineering treatise. The collection of papers does not pretend to be a textbook, nor does it emphasize applicability to engineering practice. Moreover, an avowed purpose of the colloquium is to bring out a diversity of viewpoint and opinion. Those scientists and engineers who are interested in the basic concepts of the mechanics of solids will find in this book some good summaries of recent progress, some new ideas and emphases, and considerable stimulation in the very diversity of the approach.

HORACE J. GROVER

Textbook of Polymer Chemistry

Fred W. Billmeyer, Jr., Interscience Publishers Inc., New York, N. Y., 518 pp., $10.

MODERN polymer chemistry may be considered to date back to the 1920's when Staudinger proposed his macromolecular hypothesis and Carothers carried out his classic studies on polymer synthesis. From such beginnings a major industry has developed with most of its growth occurring in the last decade. Separate courses in polymer chemistry are innovations in many colleges and universities, and few textbooks cover all of the major aspects of polymer chemistry. True, many excellent monographs describe such specific areas as fibers, plastics, elastomers, polymer processing, and polymerization kinetics. However, few books attempt to present the entire subject in a way that shows the basic concepts common to all of these fields. To this latter group, Fred Billmeyer's book will be a most welcome addition.

The book was written for graduate-level courses in the organic and physical chemistry of high polymers. It is not an exhaustive treatise on the subject, but instead is more of a narrative outline serving to collect and classify information of interest and importance on polymeric substances. Sufficient detail is included to make it valuable for reference purposes in its own right, but adequate coverage of specific areas in a polymer chemistry course will require expansion of the text by lectures and supplemental reading. Well chosen references are provided at the end of each chapter for this purpose.

Part I is a very brief introduction. It mainly serves to orient the newcomer in the history of polymer chemistry, and in those features of structure and properties that are peculiar to high polymers.

Part II, on the physical chemistry of high polymers, is one of the major portions of the book. It consists of 18 chapters covering molecular structure and its relationship to polymer properties. Both theoretical background and experimental practice are presented for subjects such as molecular weight, crystalline structure, chemical structure, solution properties, fractionation, and rheology. The mathematics employed is not complex, and experimental methods are not given in great detail.

Part III, on the kinetics of polymerization, describes first the main features of condensation and addition polymerization. Specific subjects such as absolute reaction rates, thermochemistry, copolymerization, reactivity and structure of monomers and radicals, molecular weight and molecular weight distribution, special polymerizaton systems, and polymer degradation are covered in separate chapters.

Part IV on Plastics, Part V on Fibers, and Part VI on Elastomers make up the last half of the book. Each of these describes the preparation polymers. Together, the three parts comprise the technology of high polymers. Emphasis on the relationship of the structure of each product to its properties and uses effectively relates technology to the theoretical concepts introduced in Parts II and III.

Billmeyer should certainly be useful as a text for graduate courses in polymer chemistry, and beyond that, will find its way to the reference shelves of many of those who entered the field without the benefit of such a clear and concise survey of the subject.

A. A. Harban

Quality Control for Plastics Engineers

Lawrence M. Debing, Ed., Reinhold Publishing Corp., New York, N. Y.; 142 pp.; $4.95.

This book, sponsored by the Society of Plastics Engineers, has the objective of introducing the subject of statistical quality control to the plastics industry. It is written for the plastics engineer who has no previous knowledge of statistical quality control. As such it is an interesting and probably helpful compilation of quality control techniques that should whet the appetite for more complete information.

This small volume covers a wide range of subjects including frequency distributions, control charts for both variables and attributes data, sampling inspection, process capability studies, specifications, significance tests, and experimentation. Numerous examples from the plastics industry are used to illustrate the application of the technique under discussion. Because of the limited space the ten authors have given only a brief discussion of each subject. However each chapter gives references in which detailed information may be found. In this connection, the authors of the referenced material have not been listed in the index.

There is a tendency in some chapters toward the presentation of a selected technique that is a specialty of the author rather than a description of a generally accepted method. As an example, in Chapter 6 standard sampling plans for inspection by attributes are dismissed as tending to "confuse plant people" and a plan for inspection by variables is described and recommended.

In general the material is well presented, and this book should be of real help not only to the plastics engineer but also to molders and fabricators of plastics products.

M. K. Kruger

BOOKS RECEIVED

Handbuch der Sonderstahlkunde—Vols I and II. Springer-Verlag, Berlin (1956)

Manufacturing Processes—4th Ed. M. L. Begeman; John Wiley & Sons, Inc., New York, N. Y.

Encyclopedia of Chemical Technology—Vol. 15. Waxes to Zymesterol and Index to Vols. 1–15. Interscience Publishing Co., New York, N. Y.

Modern Applied Photography. G. A. Jones; Philosophical Library, New York, N. Y.

Fatigue in Aircraft Structures. A. M. Freudenthal; Academic Press, Inc., New York, N. Y.

Analysis for Production Management. Bowman and Felter; R. D. Irwin, Inc., Homewood, Ill.

Heating, Ventilating, Air Conditioning Guide—35th Ed. American Society Heating and Air Conditioning Engineers.

Engineering Structural Failures. R. Hammond; Philosophical Library, New York, N. Y.

Brittle Behavior of Engineering Structures. E. R. Parker; John Wiley & Sons, Inc., New York, N. Y.

Control of Steel Construction to Avoid Brittle Failure. Welding Research Council, New York, N. Y.

Protective Painting of Structural Steel. Fancutt and Hudson, Macmillan Co., New York, N. Y.

Semimicro Qualitative Organic Analysis. Cheronis and Entrikin; Interscience Publishers, New York, N. Y.

Solvent Extraction in Analytical Chemistry. Morrison and Freiser, John Wiley & Sons, Inc., New York, N. Y.

Science of Engineering Materials. J. E. Goldman, John Wiley & Sons, Inc., New York, N. Y.

OTS Research Reports

These reports, recently made available to the public, can be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Order by number.

The Relationship of Hardness Measurements to the Tensile and Compression Flow Curves

Results of experimentation with magnesium-aluminum alloys showed that the approximation of a uniaxial tensile stress flow curve from hardness measurements is possible by utilizing empirical conversion constants. Agreement of the tensile and hardness testing methods is possible upon metals such as aluminum, copper, and steel. However, magnesium is not amenable to such a conversion of testing procedures, a result believed influenced by the presence of profuse twinning at low stress levels.
PB 121144; 14 pp.; 50 cents.

Development of Subminiature High-Temperature Capacitors

Teflon met or exceeded all requirements for replacement mica capacitors (specification MIL-C-5A) under temperatures from −60 to 200 C. The single exception was r-f current rating, which could not be applied to metal-cased units because of overheating. Only two obstacles, neither serious, remain before Teflon capacitors could replace mica units in almost any application: stabilization of capacitor elements and encasement for radio-frequency operation.
PB 111729; 79 pp.; $2.

An Investigation of the Effect of Anticorrosive Admixtures to Oils by the Method of Radioactive Tracers

Translated from Russian.

It is demonstrated that a film is formed on lead, steel, and lead-bronze plates, with the participation of the principal component in the additives, in this case sulfur or phosphorus. The film formation depended on oil temperature, time, character of the additive, concentration of the additive in the oil, and the metal surface. A diffusion of sulfur deep into the metal and a combination of the metal with the oil as a result of a chemical reaction between them also are demonstrated.
PB 121740; 18 pp.; 50 cents.

Alaskan Test Site Oil Exposure Program

Data from a two-year test conducted at Fairbanks, Alaska, showed that prolonged outdoor cold storage increased the pour points of ten petroleum oil samples while the pour points of four synthetic oil samples remained stable. Aircraft piston engine oil and automotive engine oil had a sufficiently low pour point and did not seem to be affected too much by the lower temperatures. With the increased use of synthetic oils, the author concludes, there should be no problem with low temperature after storage. **PB 121846; 59 pp.; $1.50.**

Micro Lubricant Test Methods. Part IV: Evaporation Loss of Lubricating Greases and Oil, Viscosity of Lubricants at −65 F, and Foaming Characteristics of Crankcase and Aircraft Engine Lubricating Oils.

This report describes miniaturized tests for quantities of petroleum, petroleum products, and related materials which are too small for analysis by macro tests. The other three parts in this series were released earlier and are still available.
PB 121849; 17 pp.; 50 cents.

Investigations of Deformation and Fracture of Metals

Plastic deformation of pure metals was investigated as a function of temperature and grain size. Correlations of the stress, strain, and strain rate were made on a phenomenonological basis for both tension and creep tests, and the resulting data applied to examination of current concepts of deformation. Among the major conclusions was an observation that there are differences between pure metals which can be related to differences in the character of the dislocations present and their interaction with purity atoms. The mathematical representation of creep and tensile curves was found adequate, but it was doubted that valid knowledge concerned with mechanisms of plastic deformation could be deduced from such expressions. In a study of effects of dispersions on the mechanical properties of magnesium-aluminum alloys, the presence of particles was shown to influence strength by affecting the primary mode of deformation. For magnesium, particles reduced the amount of twinning and thus changed deformation behavior.
PB 111838; 75 cents.

Survey of Low-Alloy Aircraft Steels Heat-Treated to High Strength Levels

Part 1—Hydrogen Embrittlement—discusses the phenomena resulting from hydrogen retained by the steel until it is subjected to laboratory and field tests and is put in service. Many failures in steel parts for aircraft having a strength above 200,000 psi and in steel bolts with strength considerably below that stress were attributed to changes in the basic mechanical characteristics of the steel caused by cadmium or chromium plating. Relief by heat-treating or baking was

(Continued on page 54)

Equipment for Corrosion and Heat-Treatment Studies of

Radioactive Materials

By G. D. CALKINS,

J. E. WHITNEY,

E. C. LUSK

Methods and equipment for corrosion testing and heat treatment of highly radioactive materials conserve hot-cell space and reduce costs

THE EQUIPMENT and method described in this paper consist of loading the radioactive test specimens into an autoclave or furnace in a hot cell. The autoclave or furnace is contained in a specially designed lead cask that serves as a radiation shield. This unit can be safely removed from the hot cell for operation during the actual corrosion test or heat treatment. The unit is then returned to a hot cell for removal and inspection of the specimens.

Description of Equipment

An essential component of the equipment is a special lead-filled steel cask built to contain a furnace or autoclave, Fig. 1. In addition to being an explosion shield to the heat-treatment vessel, the cask was designed to provide radiation shielding for specimens having activities of the order of 20,000 curies of a 1-Mev gamma emitter. As an additional precaution, steel cubicles have been built to house the cask during operation. The furnace or autoclave heater leads and pressure lines are brought through the cask wall so that connections can be made to power lines.

The casks were fabricated from $\frac{1}{4}$-in. hot-rolled steel. They are cylindrical with outside dimensions of 25 in. in both diameter and height. The steel bottom of the cask is 25 in. square and four 5-in. steel swiveled wheels are mounted on the corners. The top of the cask has a 2-in. recess which is 16 in. in diameter. The cask lid fits into this recess and provides a radiation lock. The center hole in the cask extends downward $16\frac{3}{4}$ in. from the top of the cask and has an inside diameter of $7\frac{3}{4}$ in. Two curved, spiraled, stainless steel tubes are provided between the inner and outer steel walls. One tube is used for the furnace or autoclave heater leads while the other is used for a drain. In addition to the spiraled tubes for leads, a slot is provided in the top of the cask for pressure lines and thermocouple leads (see Fig. 1). This slot and the matching key in the lid made an angle of 30 deg with the radius so that there is no direct radiation path. After the steel was fabricated, the cask was inverted, filled with lead, and the bottom plate welded in position.

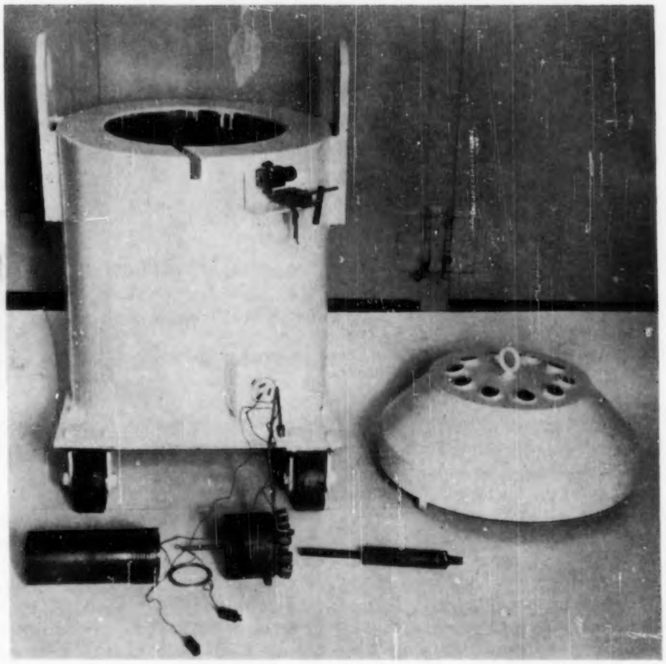

Fig. 1.—Autoclave and cask for extra cell operation.

The standard autoclave, pressure gasket, cap, and a typical closure wrench are in the foreground. Note the pin on the side of the cap which positions it in the autoclave. The projection on the bottom of the lid, extreme right, fits into the slot on the top of the cask.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

The Authors . . .

G. D. CALKINS, chief, radioisotope and radiation research, Battelle Memorial Institute, has conducted and supervised research involving radioactive materials for 10 years and was responsible for the design of Battelle's hot-cell and radiochemical laboratories and equipment.

J. E. WHITNEY, assistant chief, radioisotope and radiation research, Battelle, has had five years of experience in research with radioactive materials and is currently in charge of operations at Battelle's hot-cell laboratory.

E. C. LUSK, mechanical engineer, radioisotope and radiation research, Battelle, has had three years of experience in the design of hot-cell equipment and facilities.

Fig. 2.—Autoclave positioned in cask.
The top of the straps for the furnace and autoclave holder are visible. The strap on the far side is slotted for positioningthe cap. Note the pressure tubing and thermocouple leads in the slot.

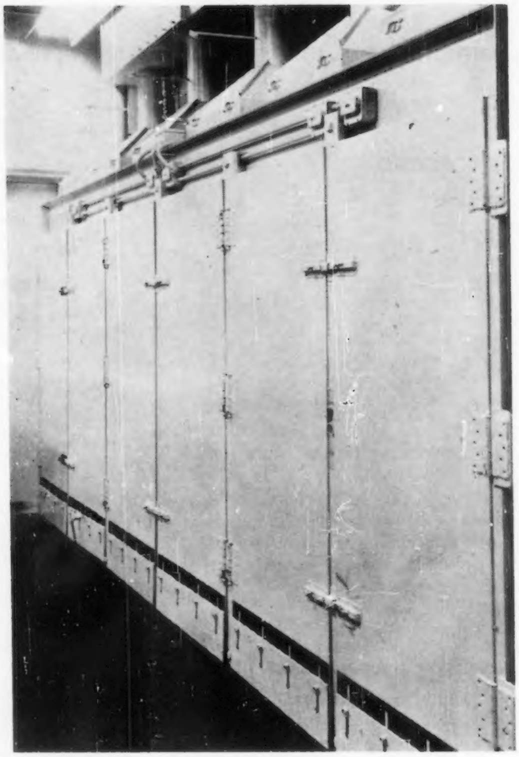

Fig. 3.—General view of cubicles for postirradiation heat treatments.
Note power switches. Doors above the channel beam allow easier removal of Fiberglas filters.

For the heat-treatment cask, a 2-in. ID tube furnace is mounted vertically in the cask. A stepped lid provides an 8-in. shield over the furnace. An eye bolt is fastened in the lid so that it can be removed remotely by the cell crane. In order to prevent excessive heating of the cask during operation, both the lid and the cask are provided with $\frac{1}{4}$-in. tubing, spiraled within the lead so that air or liquid may be circulated as coolants.

In the case of the corrosion cask, a special autoclave holder, heaters, cask lid, and wrenches have been designed. A steel cylindrical holder is mounted in the cask cavity and held 1 in. from the bottom by four hangers made from 2 by $\frac{3}{8}$-in. flat stock. Chromalox strip-heating elements are mounted vertically on the outside of the holder and held in position with $\frac{1}{8}$ by $\frac{3}{4}$-in. steel clamp bands.

A 1 liter nonagitated type autoclave designed by Autoclave Engineers is used for corrosion testing. This autoclave has an axial thermocouple tube mounted in the cover. The autoclave is sealed by 12 cap screws set into the cap at an angle of 15 deg from the vertical. The autoclave mounted in the cask is shown in Fig. 2.

In order to close an autoclave properly, the cap screws have to be tightened to definite torque values. As a result of the extreme pressure and sense of touch required, this operation is difficult to perform remotely. Consequently, a special cask lid and wrenches were made to permit manual closing of the autoclave containing radioactive materials outside the hot cell. The lid and wrenches are shown in Figs. 1 and 2. Stepped tubes were inserted in the cask lid prior to pouring the lead and each aligned with a cap screw. Since the cap screws were not symmetrical in alignment, the autoclave can be closed only when the cap is in one position. By cutting a V-slot in one of the hangers described above and putting a $\frac{1}{2}$-in. round pin in the autoclave cap, the cap is aligned exactly with respect to the cask when the pin is lowered into the slot. The lid is positioned when the key fits into the slot on the top of the cask.

The wrenches for closing the autoclave are approximately 14 in. long. The inner end of the wrench is solid alloy-hardened steel having a diameter of 0.650 in. and the end cut hexagonally to fit a $\frac{3}{4}$-by-10 Allen cap screw. The section is approximately $5\frac{1}{2}$ in. long. The steel was bored out of the larger center section of the wrench and the cavity filled with lead. The outer end of the wrench is closed with a hardened cap shaped so that a torque wrench can be applied.

The six cubicles for postirradiation corrosion testing and heat treatments are shown in Fig. 3. Alternate center partitions are removable to double the size of the cubicles when necessary. A channel beam was mounted in the wall and posts extended to the floor. The interior walls and doors are constructed of $\frac{1}{4}$-in. steel plate. Hinges and slide fasteners are welded to the posts. An adjustable lower section of each door permits a close fit of the door with the floor. Switches are provided above each door to shut off the power in case of emergency. Power and thermocouple leads are run through closed conduits out of the cubicles to a nonradioactive area where controller recorders are operated. A standard 2-in. Fiberglas filter is mounted in the ceiling of each cubicle above the filters. Ducts from each cubicle lead into a plenum chamber and thence to the main duct from the radiochemical hood. This duct passes through another Fiberglas filter and a Cambridge Micropore filter before being exhausted to the atmosphere.

Use of Equipment

Heat Treatment

The temperatures involved in heat-treatment studies are high enough so that the surface of unclad specimens must be protected from the atmosphere.

Also, it is often desirable to measure the amount of fission gases that are released during the heat treatment. To accomplish this, special Vycor capsules have been designed to contain the specimens. These capsules have the male portion of ball joints on each end, a breakoff tip, and a drawn-down section only large enough to accommodate the specimen. A manifold having the female portion of the ball joints, a pressure-measuring device (such as an Alphatron), and a line for flushing the system with pure argon is set up in the cell. The specimens are loaded into the capsules and the pressure reduced to 10 to 40 μ using a vacuum pump and dry ice trap. The evacuated system is flushed several times with argon. The capsules are then sealed off at the drawn-down section of Vycor using a gas-oxygen torch with the manipulator. The encapsulated specimens are loaded into the furnace which is mounted in the shielding cask and the cask removed to the cubicle for heat treatment.

Upon completion of the heat treatment, the cask is returned to the cell and unloaded. Another manifold system is used for de-encapsulation. This is a capillary system having a pressure-device and a series of gas sample vials. These vials have approximately 1 ml capacity below a standard taper stopcock. The vials are attached to the manifold by ball joints. A slug of iron is introduced into the tube containing the heat-treated specimen prior to attaching to the manifold at the ball joint. An electromagnet mounted on rollers is then brought into position around the sample tube. The system is evacuated to a few millimeters pressure and the pump and pressure gage shut off. The magnet is then energized which causes the iron to rupture the Vycor break-off tip and the gas to equalize in the system. The gas sample vials are closed, the pressure gage line is opened, and the final manifold pressure obtained. The gas samples are analyzed using a calibrated gamma spectrometer. The specimens are removed from the Vycor tubes for post heat-treatment evaluation.

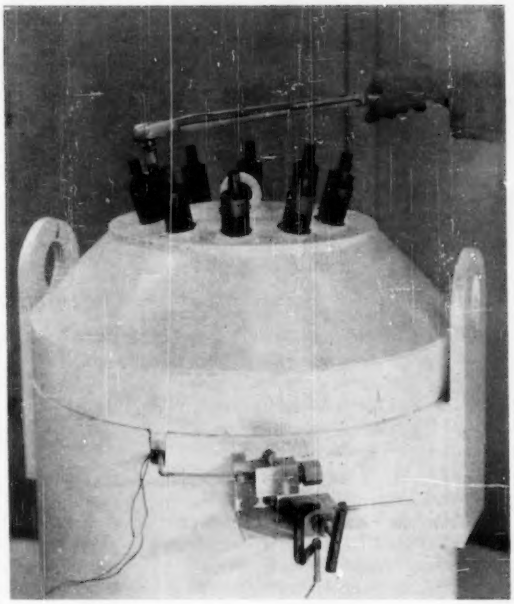

Fig. 4.—The autoclave is sealed using a fixed torque which is applied manually.

Corrosion Testing

In order to load and unload the autoclave remotely, some special tools were designed. A bench holder for the autoclave was made from standard iron pipe. A $\frac{3}{8}$-in. pin was welded inside the base of this holder to engage a hole in the bottom of the autoclave. This prevents the autoclave from rotating while the cap is being turned. Ice-tong type clamps which fit over opposite cap screws were made so that the autoclave may be removed from the cask using the cell crane. A remotely operated suction flask was built so that liquid could be removed from the autoclave. This facilitates cleaning the autoclave between runs. Special specimen containers were built enabling several specimens to be run simultaneously, each in equilibrium with its own high-purity water. By using containers which have a vapor-lock seal, the failure of one specimen in the autoclave does not affect the other specimens. Thus, several specimens may be loaded into the autoclave for simultaneous corrosion tests.

For a typical autoclave loading, the cask is placed in the hot cell where it can be serviced easily by a crane. The cask lid is placed in the cell where the crane can reach it. The autoclave lid and cap are suspended on the crane by means of the tongs. The autoclave body is mounted in the bench holder and the specimen containers and high-purity water placed on a work table. After postirradiation inspection, the specimens are placed in the special containers, a measured amount of high-purity water is added, and the specimens put in the autoclave. A sufficient amount of water is added to the autoclave to provide a level equal to that inside the containers. The autoclave cap is maneuvered over the autoclave and the ice tongs removed. The cap is then turned down to a predetermined position with a master-slave manipulator. The cap screws are also turned down. The ice tongs are re-attached and the autoclave is moved into the cask with the crane. When the pin on the cap has been placed in the V-slot in the holding bracket, the cap is properly aligned with the cask. A thermocouple is inserted into the axial well and the thermocouple and pressure tubing placed in the exit slot. The lid is placed on the cask with the crane and the wrenches inserted with the manipulator. The cask is then removed from the cell, the wrenches adjusted until each engages its cap screw, and the autoclave sealed by applying a fixed torque to each cap screw according to a standard procedure. The tightening of the cap screws is seen in Fig. 4. The cask is placed in a cubicle and the autoclave is partially evacuated. The power leads and thermocouples are connected to the recorder controller and the power is applied. At the conclusion of the test, the temperature is lowered slowly. When room temperature is reached, the leads are disconnected and the cask returned to the cell. The opening procedure is the reverse of that used in closing the autoclave.

Summary

An apparatus for conducting post-irradiation heat treatments outside of the hot cells was constructed and tested. A typical heat-treatment experiment was described including measurement of fission gas evolved during treatment. A postirradiation corrosion experiment was described. A procedure for testing several specimens simultaneously in the autoclave is included.

The Vicat Softening Point Test for Plastics

By C. E. STEPHENSON and A. H. WILLBOURN

An indentation test carried out under conditions of uniformly rising temperature has been adopted by the British Standards Institution

THE Vicat softening point test described here is a development from the Vicat-needle test adopted by the Verband Deutscher Elektrotechniker (along with the Martens test) for characterizing the form-stability of rigid electrical insulating materials.[1] This is an indentation test carried out under conditions of uniformly rising temperature, and the apparatus is of the same basic design as that devised by Vicat in the late 19th century for determining the setting time of cement.[2]

In the Vicat-needle test[1] the temperature is determined at which a cylindrical needle with a flat face 1 sq mm in area, and loaded to apply a total thrust of 5 kg has penetrated the surface of the specimen to a depth of 1 mm while the temperature of the surrounding air is raised at the rate of 50 C per hr. It is one of five softening point tests in current use in which a specimen is subjected to an arbitrarily fixed stress while the temperature is raised, and then that temperature is noted at which the specimen deformation has attained a predetermined figure. The other tests are:

1. The Martens test, adopted in German[3] and French standards.[4]
2. The heat distortion test, adopted by the American Society for Testing Materials.[5]
3. Resistance to heat test (Tenue à la chaleur), adopted in France by the Union Technique des Syndicats de l'Electricité[6]
4. Softening point test adopted in Great Britain in British standards for polystyrene and cellulose acetate molding materials.[7]

All these four tests are carried out on specimens in the form of bars which are subjected to bending moments. The first three tests are in principle very similar to each other, although in the Martens test, four-point loading is specified whereas in the American and French tests three-point loading is used; however, the permitted deformation is small (about 0.2 per cent strain at the softening temperature). In the British softening point test, a cantilever is used and the temperature determined is, for all practical purposes, that at which the specimen collapses. It is not the purpose of this paper to discuss the relative merits of these tests; the first three have recently been discussed by von Meysenbug who describes in detail the development of the Martens test and stresses the advantages which in theory it has over the three-point loading test procedures (**1**).[8] An analysis of these tests in another connection has been made by Thomas (**2**). It can be seen, however, that the Vicat test is very different from all the others, and one might expect it to have special advantages, as well as limitations, of its own. This is in fact found to be so.

Development of the Vicat Softening Point Test

The Vicat-needle test was adapted to the testing of electrical insulating materials over 30 years ago,[9] at a time

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[1] "Leitsätze für mechanische und thermische Prüfungen fester Isolierstoffe," Verband Deutscher Elektrotechniker 0302/III.43 (1943).

[2] For example, "Portland Cement (Ordinary and Rapid Hardening)," British Standards Institution, B.S. 12: 1947.

[3] "Prüfgerät für die Bestimmung der Formbeständigkeit in der Wärme nach Martens," Deutscher Normenausschuss, DIN 53462 (1954); "Bestimmung der Formbeständigkeit in der Wärme nach Martens," Deutscher Normenausschuss, DIN 53458 (1954).

[4] "Méthodes d'Essais des Matières Plastiques Utilisées dans la Construction Electrique," Essais, G. "Détermination de la Déformation a la Chaleur," L'Union Technique de l'Electricité, NF-C.46 (1952).

[5] "Method of Test for Heat Distortion Temperature of Plastics" (D 648-56), 1956 Book of ASTM Standards, Vol. 6, p. 296.

[6] "Tenue à la Chaleur," L'Union Technique des Syndicats de l'Electricité, Publication 1009 (1937/38).

[7] "Polystyrene Moulding Materials," British Standards Institution, B.S. 1493: 1948; "Cellulose Acetate Moulding Material," British Standards Institution, B.S. 1524: 1955.

[8] The boldface numbers in parentheses refer to the list of references appended to this paper.

[9] For example, 1924 Edition of footnote.[1]

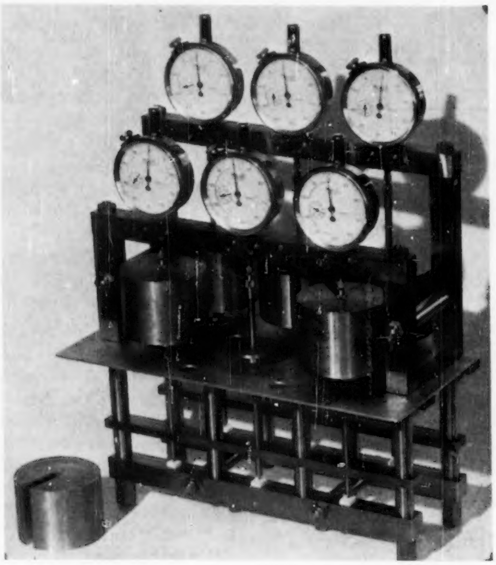

Fig. 1.—Vicat softening point apparatus—Standard 6-unit model.

when the plastic compositions in use were mostly of the hard, heavily filled or cross-linked variety, for example, ebonites and bituminous compositions. In cement testing, a low load of the order of 300 g was used, but this was inadequate to make much impression on these early plastic compositions; the load was therefore raised to 5 kg. Even so the test was not suitable for very hard synthetic resins of the phenol-formaldehyde type, and suggestions were made that the permitted indentation should be reduced to 0.10 mm, although this raised severe difficulties in measurement. The test was carried out, and still is, by putting the apparatus in an air oven and raising the temperature of the air at the rate of 50 C per hr. (**3, 4**).

The Vicat-needle test has never attained the status, for instance, of the Martens test, nor has it been in general use in the plastics industries of the major industrial countries. There seem to have been two major causes for its relative obscurity. In the first place, it was not devised for testing thermoplastics, which have since attained such a dominant position in the plastics industry. Secondly, the experimental difficulties of obtaining reproducible results are considerable; thus, it is difficult to keep the temperature spatially uniform and rising at a constant rate in an air oven; the apparatus must be quite rigid to support the 5-kg load, and differential expansion effects are difficult to eliminate, and the temperature of the specimen can lag by as much as 20 C behind that of the air.

The Vicat softening point test[10] as developed in these laboratories differs in two obvious ways from the Vicat-needle test in that it has a smaller load—1 kg as against 5 kg—and in having a liquid as the heat transfer medium instead of air. The mechanical design of the test units has also passed through several stages of development before a finally satisfactory apparatus was obtained. The use of a liquid heat-transfer medium improves the reproducibility of the test and simplifies the design of the apparatus and its operation. It is of course necessary to use a liquid which does not affect the material under test. For most materials, either transformer oil (for example as specified in British Standard, No. 148) or glycerine are suitable; in exceptional cases one of the silicone fluids may have to be used (these have the advantage also of having very high boiling points).

Figure 1 shows a standard 6-unit apparatus such as is used extensively in these laboratories; the test specimens are shown in position. The dial gages measure 1 mm per revolution and are graduated in hundredths; the limits of thrust conform with clause 9 of British Standard No. 907 (1954). The apparatus is constructed of low-expansion alloy (for example Nilo 36) which is essential if full advantage is to be taken of its potentialities. For routine testing, however, an apparatus constructed of conventional materials, plated brass or steel, gives quite satisfactory results although it is advisable to check whether any corrections for differential expansion should be made.

Method of Test (See Fig. 1)

The detailed description of the method follows:

(1) The test specimen is about $\frac{3}{8}$ in. sq and not less than $\frac{1}{8}$ in. thick: if very much thicker ($>\frac{1}{4}$ in.), it is reduced to about $\frac{1}{8}$ in. and placed in the apparatus with the newly cut face uppermost.

(2) The specimen is placed in the apparatus, taking care that it is properly settled in good contact with the framework. The needle is placed not nearer than $\frac{1}{8}$ in. to any edge of the specimen.

(3) The apparatus is put in the heating bath, which should be at a temperature about 50 C lower than the expected Vicat softening temperature. After 5 min, the dial gage is set to zero, and the weight added to bring the total load on the specimen up to 1 kg (the thrust of the dial gage is ignored).

(4) The temperature of the bath is raised uniformly at the rate of 50 C per

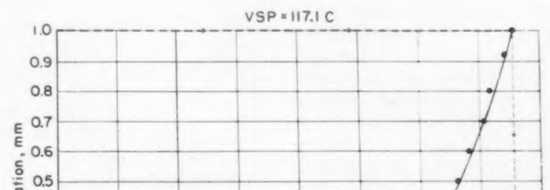

Fig. 2.—Indentation *versus* temperature for a specimen of Perspex.

[10] This test method has been adopted in essentially the form described by the British Standards Institution; see "Methods of Testing Plastics: Effect of Temperature," B.S. 2782, Part 1:1956. Method 102-D.

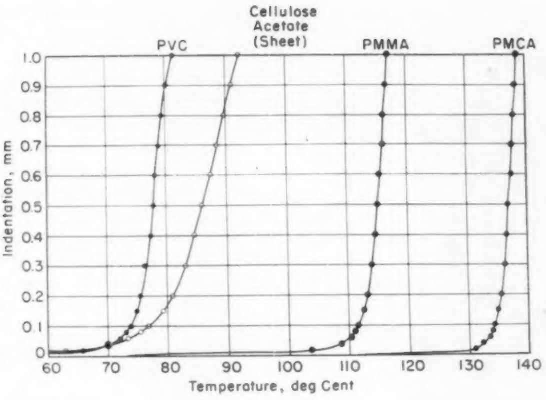

Fig. 3.—Indentation *versus* temperature for:

PMCA—poly(methyl-α-chloroacrylate)
PMMA—poly(methyl-methacrylate)
PVC—poly(vinyl-chloride) (unplasticized)
Cellulose Acetate (sheet)

hr, and readings of the indentation and temperature are taken at appropriate intervals to enable a graph to be plotted. The Vicat softening point (VSP) is the temperature at which the indentation is 1.00 mm.

It will be appreciated that this procedure may be varied in detail to suit special materials or for specific purposes. It is, however, important to maintain a uniform rate of temperature rise, particularly in the temperature region near the VSP; a convenient time interval for checking the rate is every 3 min, during which the temperature should rise $2\frac{1}{2}$ C. Quite a satisfactory method of control is to adjust an immersion heater to give the correct rate at the start of the test, and then to increase the power input (in the same heater or in a subsidiary one) by manual adjustment of a variable transformer. Alternatively, the same procedure can be effected automatically using a sensitive variable temperature controller; simple on-off types of program controllers have not proved to be suitable.

Figure 2 shows a curve of indentation *versus* temperature for a specimen of Perspex[11] (poly(methyl-methacrylate) sheet). For this particular specimen the Vicat softening point (VSP) is 117 C. It will be noted that at the VSP, the indentation is increasing very rapidly with increasing temperature so that a small error in measuring the indentation has an insignificant effect on the value of the VSP. This is a considerable advantage and holds for most thermoplastics to a greater or lesser extent.

It is sometimes desirable to have a measure of the rate at which a material softens with rise in temperature, and for this purpose it has been found convenient to record the "one-tenth Vicat softening point ($\frac{1}{10}$ VSP), that is, that temperature at which the indentation is 0.10 mm. In the example shown, the $\frac{1}{10}$ VSP is 111.5 C; the difference, Δ VSP, is then an arbitrary measure of the softening range of the material. If the $\frac{1}{10}$ VSP is to be measured, it is essential to construct the apparatus from low-expansion alloy.

It will be appreciated that the great advantage of this test is that it is carried out on a small specimen, the shape of which is relatively unimportant. It must have one good flat surface, must be reasonably parallel-sided, and between $\frac{1}{8}$ and $\frac{1}{4}$ in. thick. Thinner specimens can be stacked together, but this results in some loss in accuracy and in a greater scatter of results.

The results from this test can be correlated with the results obtained on other softening point tests, subject to certain restrictions, as will be described in a later paper; and the use of the test in conjunction with the loaded-beam type of test (for example, the heat distortion test (ASTM D 648-56)[5] can give useful information not obtainable from either test alone.

Application of the Test to Different Plastics

Indentation *versus* temperature curves obtained with four thermoplastics are shown in Fig. 3. The softening behavior of these plastics differs appreciably, and this is indicated by the values of Δ VSP quoted in Table I.

TABLE I.—THE SOFTENING BEHAVIOR OF VARIOUS PLASTICS.

Material	VSP, deg Cent	$\frac{1}{10}$ VSP, deg Cent	Δ VSP, deg Cent
Poly(methyl-α-chloroacrylate).....	139	134	5
Poly(methyl-methacrylate)...........	117	111	6
Poly(vinyl-chloride) (unplasticized).....	81.5	74	7.5
Cellulose Acetate (sheet)............	92.5	77	15.5

The test as normally carried out is suitable only for thermoplastics, since heavily cross-linked (thermoset) plastics do not soften catastrophically at any temperature below their decomposition temperatures and cannot therefore usually accommodate an indentation of 1 mm. Measurements of $\frac{1}{10}$ VSP are however often possible, and are sometimes of value.

Special considerations also apply when the test is used on crystalline polymers such as polyethylene and nylon. With these polymers the test gives a measure of the temperature at which the melting of the crystalline regions has progressed to such an extent that they no longer reinforce adequately the already softened amorphous regions. Furthermore, some of these materials tend to creep under the applied load even at room temperature, that is, the initial indentation at room temperature is appreciable and gradually increases with time. The VSP is therefore a complex function of the crystalline melting point, the range of temperature over which the crystals melt, the degree of crystallinity and the properties of the amorphous regions. Hence although the test in the form described can be of use in comparing the behavior of different samples of the same crystalline polymer, it is of less use in comparing different crystalline polymers with each other or with amorphous thermoplastics (a modified method has been developed which has advantages in testing crystalline polymers; this will be described in a forthcoming publication). Data on samples of polyethylene, polymethylene and two nylon polymers are given in Table II.

TABLE II.—MELTING POINTS AND VSP TEST DATA FOR CRYSTALLINE POLYMERS.

Material	Crystalline Melting Point, deg Cent	VSP, deg Cent	$\frac{1}{10}$ VSP, deg Cent	Δ VSP, deg Cent
Polyethylene.	110	90	65	25
Polymethylene.	137	132	104	28
Nylon 6-6....	265	256	246	10
Nylon 6-10...	215	211	183	28

[11] Registered trademark.

Factors Affecting the Test Results

Before considering the inherent reproducibility of the test, it will be convenient to consider how the Vicat softening point of a plastic is affected by variations in the state of the test specimens. The factors operative will differ with different materials, but clearly any plasticizer present will, almost by definition, lower the VSP. Apart from materials normally considered as plasticizers and deliberately added to soften the material, any other low-molecular-weight material present fortuitously will have the same effect if it is truly compatible with the polymer. For example, absorbed water may cause a lowering in VSP, as also may residual unpolymerized monomer if any happens to be present. Both these effects, due to absorbed water and residual monomer, are shown by test data on poly(methyl-methacrylate), and they can be fairly readily separated since both the water content **(5)** and the monomer content **(6)** of poly(methyl-methacrylate) can be determined independently by an infrared absorption method. Figure 4 shows the relation between water content and VSP in a particular sample. It turns out that 1 per cent of water results in a lowering of VSP by 7 to 8 C.

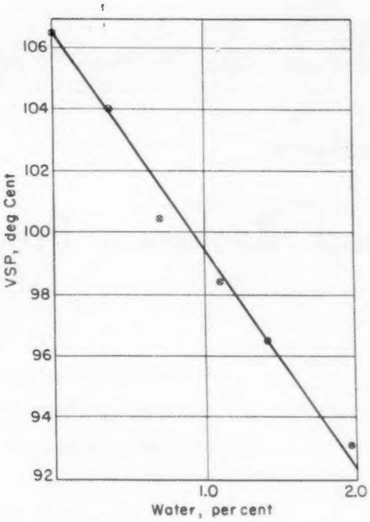

Fig. 4.—The effect on VSP of absorbed water in a sample of poly(methyl-methacrylate).

It might be thought that strain in the specimen introduced by thermal shock would affect the VSP profoundly. This is by no means generally true, and this unusual feature of the test can be turned to some advantage in ways which will be discussed in a forthcoming paper.

The inherent reproducibility of the test and the variation in test results from apparatus to apparatus can be investigated when all sources of irreproducibility in test specimens have been eliminated. This has been done using specimens taken from a specially prepared sheet of poly(methyl-methacrylate) thus ensuring as far as possible that all the specimens were identical; all were kept perfectly dry before testing. The investigation was carried out using six of the standard 6-unit models located in different laboratories and each with a different operator. Three tests were carried out with each apparatus, involving 18 specimens; in all, there were 108 test results. Analysis of these results led to the values of the standard deviations given in Table III.

TABLE III.—THE REPRODUCIBILITY OF TEST RESULTS: SUMMARY OF ROUND-ROBIN DATA.

Standard Deviation from Unit to Unit	VSP, deg Cent	$\frac{1}{10}$ VSP, deg Cent
In the same apparatus, tests done simultaneously	0.22	0.32
In the same apparatus, tests done at different times	0.34	0.48
For all tests (that is, different apparatus and different runs)	0.54	0.55

Thus the standard deviation of any result, irrespective of the apparatus used, of the particular unit in the apparatus or of the time of testing, is 0.54 C for the VSP and 0.55 C for the $\frac{1}{10}$ VSP. This may be generalized in the form: a test result obtained with a standard 6-unit Vicat softening point apparatus will differ by more than 1 C from the true value of the VSP (or $\frac{1}{10}$ VSP) of the specimen only once in twenty times.

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Relationships between

Electrical and Mechanical Properties of Epoxy Plastics*

By JOHN DELMONTE

When adequate correlations are established, electrical parameters could be used to observe mechanical changes, providing, in effect, a nondestructive test

CORRELATIONS between electrical properties and mechanical properties of epoxy plastics become possible when comparisons are made under these well defined conditions:

1. Electrical and mechanical properties are examined at various temperatures, maintaining a constant chemical composition.
2. Electrical and mechanical properties are determined at a given temperature for various changes in chemical composition. This is particularly true if the material variable is highly polar in character, or a polymer addition which contributes to greater elongation.
3. At a given temperature and for a given composition, changes in mechanical stresses will produce changes in certain electrical properties.
4. Prolonged exposure to high temperature will also lead to thermal degradation manifested by correlative changes in the physical and electrical properties.

These relationships may be demonstrated by numerous examples, and in this paper test data are presented to illustrate them. Epoxy resins have been chosen as an ideal material to compare physical and electrical properties. Their low shrinkage and absence of volatile constituents during cure insure stable solid dielectrics suitable for examination. Absolute correlations were not observed, such that one could examine the physical properties at a given temperature and predict the electrical characteristics or vice versa.

There are advantages to be gained from these studies. When adequate correlations are established, one may utilize electrical parameters for observing mechanical changes in dielectric materials. These observations are usually nondestructive in character, whereas mechanical tests are generally destructive. Furthermore, data such as presented herein offer more information to designers on the influence of the service conditions of stress and temperature on dielectric behavior. Data of this type are not too readily available for the epoxy resins which are assuming more responsible roles in the field of electrical insulation.

Temperature Changes

The changes in electrical and physical properties of an unfilled rigid epoxy resin with three different curing systems reveals significant changes in flexural strength and volume resistivity with changes in temperature, though dissipation factors observed at various temperatures at frequencies of 110 kc and 1.1 mc gave somewhat anomalous results.

The epoxy resin used had an epoxy equivalent per 100 g in the range of 0.495 to 0.500 (approximately 200 g of resin per epoxy mole equivalent). Three curing agents were employed. A (a proprietary aromatic amine); B (a polyamine diethylene triamine); and C (a proprietary type

TABLE I.—CHARACTERISTICS OF CAST EPOXY RESINS.

Curing Agent	Cure Schedule	Post Cure	Heat Distortion Temperature[a]
A — Aromatic Amine[b]	2 hr 200 F, 2 hr 300 F	2 hr 400 F	292 F
B — Diethylene Triamine	24 hr at room temperature	2 hr 200 F	218 F
C — "Epocast" 17 Anhydride	2 hr 200 F, 2 hr 300 F	4 hr 400 F 14 hr 500 F	400 F

[a] Method D 648 (264 psi fiber stress).
[b] Liquid Aromatic Polyamine—HN 927 (Furane).

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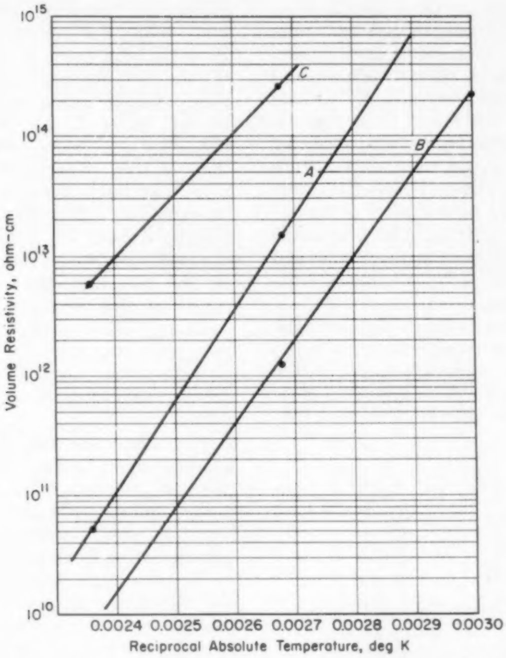

Fig. 1.—Volume resistivity shown as a function of test temperature for cast epoxy resin cured with three different curing agents.

of anhydride). Stoichiometric proportions of the amine were employed and slightly less than stoichiometric proportions for the anhydride, where optimum properties were indicated from earlier studies. The resin specimens were cast $\frac{1}{8}$ in. thick, cured between glass plates, and post-cured in the open. Flexural strength, volume resistivity, and dissipation factors were determined upon fully cured resins in accordance with applicable ASTM test methods.

One of the first objectives was to measure the heat distortion temperature according to ASTM Method D 648[1] at fiber stress of 264 psi, and observe whether electrical or physical properties demonstrated abrupt changes in the vicinity of the heat distortion temperature. As observed in Table I and in Figs. 1 and 2, it would be difficult to determine the heat distortion temperature from the physical and electrical data. At the heat distortion temperature, the average flexural strength of the cast specimens was approximately 50 per cent of the room-temperature results. As will be noted, the volume resistivity at the heat distortion temperature was lower than at room temperature by a factor of 10^3.

The temperature dependence of properties, particularly electrical properties, is influenced to a large measure by the state of cure Thus, for example, material C, illustrated in Figs. 1 and 2 and Table I, will show a lower order of volume resistivity by a factor of 10, if post-cured only at 400 F. On the other hand, materials A and B are not significantly improved by further post-cure at higher temperatures.

Data illustrating the dissipation factors at various frequencies and tested at 75 F are shown in Fig. 3 for the three representative curing agents for epoxy resins listed in Table I.

Data on the dissipation factor *versus* temperature characteristics of cured cast epoxy resins are shown in Fig. 4. Only in the test at 110 kc did the epoxy with the B-curing agent which possessed the lowest heat distortion, show an abrupt rise in dissipation factor at 300 F. Noteworthy are the low dissipation factors of the particular anhydride-cured epoxy resin system described in this paper. (This product is identified commercially as Epocast 17—manufactured by Furane Plastics, Inc.) Dielectric measurements on some epoxy and polyester resins were reported by Hazen (**1**).[2]

From this phase of the tests, the following conclusions may be reached for epoxy resins:

1. Flexural strengths fall quite rapidly for unfilled epoxy resins beyond the ASTM heat distortion temperature.

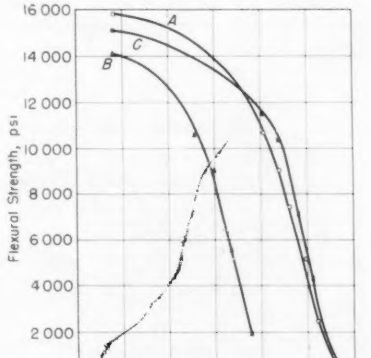

Fig. 2.—Flexural strength as a function of test temperature for cast epoxy resin cured with three curing agents (see Table I).

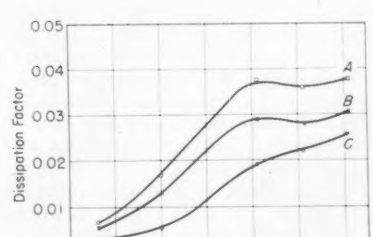

Fig. 3.—Dissipation factor at various frequencies of cast epoxy resin cured with three curing agents (see Table I).

[1] Tentative Method of Test for Heat Distortion Temperature of Plastics (D 648–56 T) 1956 Book of ASTM Standards, Part 6, p. 296.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

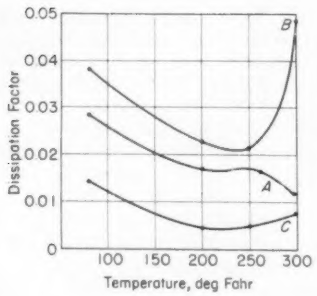

Fig. 4.—Dissipation factor-temperature relationship for cast epoxy resins at 110 kilocycles.

2. The log of volume resistivity *versus* reciprocal of absolute temperature is a straight-line function.

Resilient Epoxy

There are many commercial applications for resilient epoxy resins including requirements for high impact strength and the need for materials to accommodate wide expansion differences. These qualities may be imparted to the epoxy resins through polymeric additives, such as polyethers, polyamides, polyesters, or polysulfides. The results are particularly effective when the epoxy resin is coreacted with polymers containing reactive terminal group.

An interesting study was made of a proprietary resilient epoxy, Epocast 15 (Furane Plastics Inc.) demonstrating interesting correlations between electrical and physical properties upon prolonged aging at 300 F. Test specimens were prepared from sheets, $\frac{1}{8}$ in. thick, cast and cured between glass plates for 5 hr at 200 F and 2 hr at 250 F. ASTM tension test bars were prepared and ultimate stresses (based on dimensions at time of failure) and elongation were determined. At the same time, additional $\frac{1}{8}$-in. panels were post-cured in an air-circulating oven at 300 F, up to 7 days. Both electrical and physical properties were evaluated at 75 to 80 F after prolonged exposures to 300 F. All specimens were poured from the same mix and cured simultaneously, minimizing material variables.

The results depicted in Fig. 5 suggest that elongation measurements and loss in weight are important clues for this type of material. The fall-off in elongation suggests age embrittlement taking place at 300 F. The loss in weight at 300 F measured upon 6 by 6 by $\frac{1}{8}$ in. (approximately) slabs is pronounced. At first the results are beneficial showing an increase in tensile strength, accompanied by an increase in volume resistivity and decrease in dissipation factors, as shown in Figs. 5 and 6.

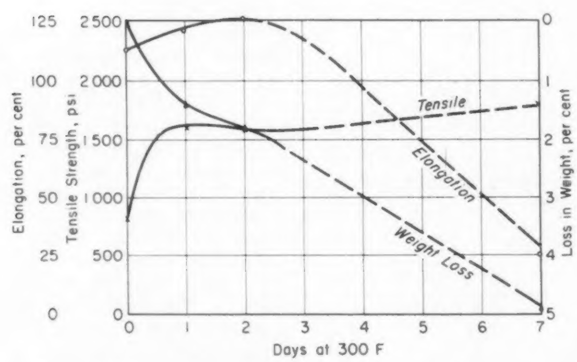

Fig. 5.—Physical properties at 75 to 80 F for Epocast 15 after exposure at 300 F.

Hazen also reports decrease in dissipation factor of silicones on aging (2). However, the point is reached where the loss reflects degradation or oxidative processes acting to the detriment of the material. Decreasing volume resistivity and elongation are indications of this. The electrical measurement has merit because it is nondestructive in character. Volume resistivity data at 140 F are reported for comparison purposes because readings on the megohmmeter were most accurate at this range. At lower temperatures, the readings were higher and less accurate. Dielectric breakdown strength was also determined but showed little or no change with aging period.

The initial increase in volume resistivity upon aging (provided aging processes do not introduce contaminants) reflects a sounder mechanical structure, due in some measure to the consummation of more chemical bonds in crosslinking. This tightening of the structure was briefly explored in another experiment where volume resistivity was evaluated upon a resilient epoxy being loaded in tension. There was a *significant increase in volume resistivity* as tension was applied, before measurable dimensional changes became apparent. On the other hand, measurements of dissipation factor at 1.1 mc indicated little or no change with increasing tensile stress. Loads were applied at a rate of 0.2 in. per min on a Tinius Olsen testing machine.

Haroldson reported a thermal stability of electrical insulating varnishes, utilizing dielectric strength tests for evaluating film deterioration (2). He concluded that crazing of the varnish film during heat aging is a definite indication of deterioration and will result in a lowering of dielectric strength. Plettner and Currin applied 1 per cent elongation to their flexible sheet insulation after aging and used dielectric

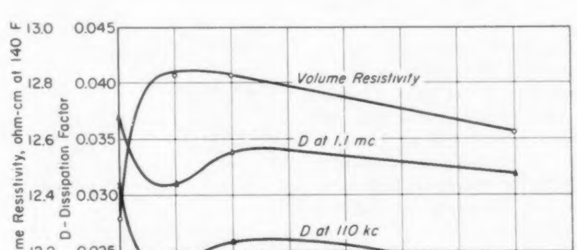

Fig. 6.—Electrical properties of Epocast 15 after exposure at 300 F.

strength to evaluate aging behavior (3). Perhaps the most noteworthy results on the effect of long-time aging on the dielectric properties of laminates have been reported by Winans and associates (4) and (5). Short-time as well as long-time exposures at high temperatures indicate pronounced transient effects in thermosetting phenolic, melamine, and silicone laminates. However, physical properties were not simultaneously determined or reported in these papers.

Changes in Composition

Volume resistivity as a sensitive means of determining the effect of changes in composition are shown in Fig. 7 for a clear cast resin. In this series of tests, a liquid epoxy resin (230 g per epoxy equivalent) was cured with different percentages of an aliphatic polyamine. Stoichiometric proportions lay in the vicinity of 10 per cent by weight of the hardener. Results are shown at 150, 190 and 240 F. The optimum properties are clearly indicated and in a manner more convincing than the results obtained purely by physical tests alone. In fact, there is good correlation between peak volume resistivity and stoichiometric proportions for cured epoxy resins.

When the variable is a change in filler, electrical properties do not necessarily provide a good criterion because the dielectric properties of the filler will have a pronounced influence on electrical measurements, though not necessarily on physical properties. Consequently, good correlation between electrical and physical properties appears possible for a given resin-filler composition, showing sensitivity to aging and temperature influences and hardener (curing agent) variables.

There is one last generalization which may be brought out for epoxy resins (filled and unfilled). In studies upon a large number of commercial grades of resins used for electrical purposes, it was apparent that volume resistivity at 140 F (where good comparative readings could be made on the instrumentation available) reflected the comparative resiliency of the material. In plotting Shore D durometer reading (5 sec at 75 to 80 F) *versus* log of volume resistivity for twelve different compounds, Fig. 8 was obtained. One can observe the practical aspect that the harder materials offer higher values of volume resistivity.

Conclusions and Comments

It is evident that for a constant epoxy resin composition, changes in volume resistivity and flexural strengths will parallel one another in the temperature range immediately below and above the ASTM heat distortion temperature. However, the heat distortion temperature cannot be predicted from either set of data for epoxy resins. A general observation that can be made is that a broad relation exists between the Shore D hardness of an epoxy resin and its volume resistivity.

The resilient epoxy resins will depict significant electrical and mechanical property changes on long-time aging at elevated temperatures. It may be possible to utilize nondestructive dielectric measurements for tracing changes in the epoxy resin compounds. Also reported was an increase in volume resistivity upon the application of small tensile stresses.

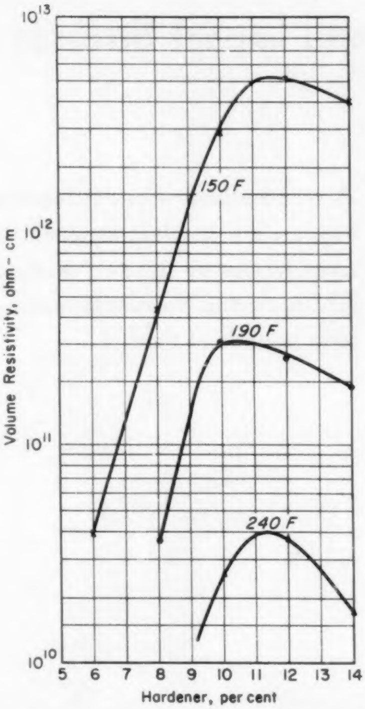

Fig. 7.—Volume resistivity as a function of the per cent hardener for a cast epoxy resin.

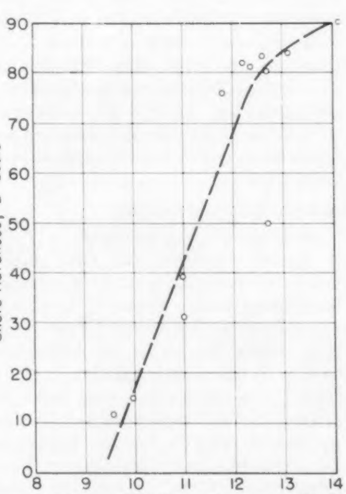

Fig. 8.—Relationship between shore D hardness and log volume resistivity at 140 F for several epoxy resins.

Acknowledgment:

The author gratefully acknowledges the assistance of Delsen Corp. (Glendale Calif.) in making electrical measurements and the assistance of Kenneth Cressy and Edward Sarna of Furane Plastics Corp. research laboratory in preparing laboratory samples and conducting physical measurements.

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Long-Term Rupture and Impact Stresses in Reinforced Plastics

By SOLOMON GOLDFEIN

A new method of evaluating strength data as a function of time and temperature involves determination of rupture properties at various temperatures by standard methods and a mathematical and graphical relationship to determine rupture properties for extremely short and long periods of time

THE EXTENSIVE time and temperature dependence of glass-reinforced plastics was not early realized. When design engineers used data from short-term static tests, using criteria established for metals, no correlation was obtained between the results of the tests and the service life of the material. Extrapolation of log time *versus* rupture stress graphs may be quite unsafe. At elevated temperatures they may be curved making them physically difficult to extrapolate. Preparation of the curves is both expensive and time consuming.

A number of stress-time-temperature relationships have been presented in the past. Larson and Miller (**1**)[1] showed that the parameter $K = T\ (20 + \log t)$ gave good results with metals at high temperatures. Manson and Brown (**2**) showed that a related parameter gave better results in the higher stress range but was unsatisfactory in the lower stress range for the same materials. Since metals at high temperatures appeared to act in a manner similar to reinforced plastics at ambient temperatures, an attempt was made by the author to apply the Larson-Miller parameter to observed data (**3**). It was found in this work that the time-temperature relation expressed by the parameter $T\ (C + \log t)$ where T = absolute temperature, C = 20, and t = time, in hours, could in general be applied to tensile and compressive rupture data on laminates fabricated from polyester and silicone resins reinforced with glass fibers. Application of this relation allowed the use of steady-load tests (up to 1000 hr) at high temperatures to determine long-time data at room temperature. The degree of accuracy was unknown since no long-time data were available as a check. Long-time rupture data obtained by extrapolation of time-stress curves agreed in most cases with data obtained by use of the parameter. In this current work, an attempt is made to correlate long-term tests at ambient temperatures of an epoxy laminate with short-time static tests at elevated temperatures in an effort to determine the accuracy of the parameter. An attempt is also made to correlate short-time static tests at low temperatures with high loading rate or impact tests.

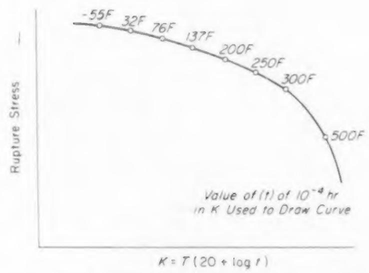
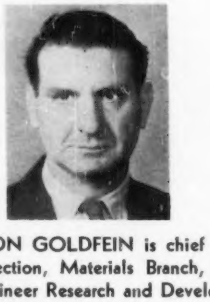


Fig. 1.—Representative master rupture curve drawn using static test data (**time—1 to 2 min approximately**).

Master Rupture Curves

Since the t in parameter $K = T\ (20 + \log t)$ represents the time during which the material is under a constant load rather than a gradually increasing load, the time to ultimate failure measured during the static test cannot be used in the parameter without excessive error. Trial and error tests have indicated that the steady-load-static-time equivalent (SLTE) for the glass-reinforced plastics under investigation is approximately 10^{-4} hr. In drawing a master rupture curve based on static tests, or what is more commonly called ultimate strength data, this value can be introduced for t in the parameter $T\ (20 + \log t)$ for all values of T. Figure 1 shows a typical master rupture curve drawn using ultimate strength data obtained at different temperatures. The value of t used throughout was 10^{-4} hr. Once the curve is drawn, however, any combination of values of temperature and time can be used to determine rupture stress. Likewise, knowing any two of the three variables (rupture stress, temperature, and time) the third may be simply obtained.

In order to correlate results calculated using master rupture curves with long-term data, a source of reliable long-term data was required. A program designed to supply long-term loading data (up to 5 yr) on glass-reinforced plastics (**4**) was already under way at Forest Products Laboratory (FPL). Arrangements were made with the Shell Chemical Co. to supply an epoxy glass-fiber-reinforced laminate identical in structure and composition to the one which they supplied to FPL. Samples of laminates currently being tested by FPL were obtained and tested at various temperatures for tensile and flexural strength in their dry condition and for flexural strength wet. The laminate was made with Epon 828 crosslinked with metaphenylene diamine.



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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

Experimental Procedures

Tensile and flexural strength were determined in accordance with methods 1011 and 1031 respectively of Federal Specification LP-406b, "Plastics Organic: General Specification Test Methods."

Tests at temperatures from −55 to 200 F were carried out at the Materials Branch, ERDL. Tests at 250 and 300 F were carried out at the Materials Lab., New York Naval Shipyard. The 500 F value was taken from the commercial literature of Shell Chemical Co. These data are given in Table I together with their calculated K values.

TABLE I.—STATIC RUPTURE STRENGTHS OF EPOXY-GLASS CLOTH LAMINATE.[a]

Temperature, deg Fahr	Temperature, deg Fahr absolute	K $K = t(20 + \log t)$ $t = 10^{-4}$ hr	Tensile Strength,[d] psi	Flexural Strength,[e] Dry, psi	Flexural Strength, Wet, psi
−55....	405	6 480	66 200	98 100	...
+32....	492	7 870	53 700	82 900	...
34....	494	7 900	...	...	86 800
76....	536	8 580	52 100	76 500	82 600
137....	597	9 550	47 600	71 600	71 200
198....	658	10 520	...	...	61 500
200....	660	10 560	45 900	64 700	...
250....	710	11 360	41 500[b]	61 800[b]	...
300....	760	12 160	34 500	55 500[b]	...
500....	960	15 380	...	11 000[c]	...

[a] Fabricated by Shell Chemical Co. to be identical with one in Table II.
[b] Determined by New York Naval Shipyard.
[c] Data from Shell Chemical Co. literature.
[d] Average of 2 to 3 specimens.
[e] Average of 5 to 6 specimens.

TABLE II—LONG TERM RUPTURE DATA OF EPOXY-GLASS CLOTH LAMINATES.[a] COMPARISON OF OBSERVED AND CALCULATED RESULTS.

Property	Temperature, deg Fahr	Time, hr	K $T(20 + \log t)$	Stress from Master Rupture Curve, psi	Calculated Stress (corrected), psi	Observed Stress (For. Prod. Lab.),[d] psi	Difference Between Observed and Calculated Stress, per cent	Remarks
Flexural strength, Dry	73	1	10 640	64 100	59 500	57 000	+4.4	Correction factor is 0.929 for Flexure
	73	10	11 170	61 600	57 200	54 000	+5.9	
	73	100	11 700	58 500	54 300	51 000	+6.5	
	73	1 000	12 230	54 000	50 200	48 000	+4.6	
	73	10 000	12 750	48 900	45 500	44 500	+2.2	
	73	20 000	12 790	48 500	45 100	44 000	+2.5	
Flexural Strength, Wet[c]	73	1	10 640	60 000	55 700	54 500	+2.2	All data taken from extrapolated curve
	73	10	11 170	55 000	51 100	50 000	+2.2	
	73	100	11 700	47 700	44 300	45 300	−1.6	
	73	1 000	12 230	43 400	40 600	40 500	+0.3	
	73	10 000	12 750	36 800	34 200	36 000	−5.0	
	73	20 000	12 790	36 500	33 900	34 000	−0.3	
Tensile Strength, Dry[b]	73	0.0113 sec	6 500[e]	65 500	67 900	68 100	−0.3	Picatinny Arsenal Data. Correction factor for tension is 1.038
	73	1	10 640	43 300	45 000	43 000	+4.6	
	73	10	11 170	41 400	42 900	42 000	+2.1	
	73	100	11 700	38 400	39 900	41 000	−0.5	
	73	1 000	12 230	37 400	38 800	39 000	−0.5	
	73	10 000	12 750	35 700	37 100	37 500	−1.1	
	73	20 000	12 790	35 500	36 900	37 200	−0.8	

[a] Fabricated by Shell Chemical Co. using Epon 828 cured with metaphenylene diamine and reinforced with style 181 gloss cloth finished with Volan A; data from Forest Products Laboratory.
[b] Static tensile strength is 54,100 psi.
[c] Static flexural strength is 71,200 psi.
[d] These data were determined from stress-time curve.
[e] See paragraph on high-loading-rate strength or impact strength for determination of this value.

Wet Strength, Flexural

Specimens were boiled in water for 3 hr and placed in a bottle containing water at the test temperature. The bottle was then capped and placed in the test chamber which was maintained at the test temperature. The specimens were conditioned for 1 hr, removed one at a time, wiped dry and tested for flexural strength immediately.

Long-Time Rupture Strength

Long-time rupture tension and flexural tests were performed at FPL on special equipment designed to measure creep (**4**) also. Table II lists the experimental results of this work up to 20,000 hr, the extent of the test to date.

Correction Factor

It was found that the samples of epoxy laminates 828 supplied by the Shell Chemical Co. to the FPL and ERDL were not identical. Table III shows the differences in properties of the two laminates and the method used to calculate correction factors. These factors were applied to the rupture strengths obtained from the master rupture curves so that a fair comparison between the calculated and observed results would be obtained.

TABLE III.—CALCULATION OF CORRECTION FACTORS FOR DATA ON EPOXY-GLASS CLOTH LAMINATE.[a]

	Temperature, deg Fahr	Tensile Strength, psi	Flexural Strength, psi
ERDL......	76	52 100	76 500
ERDL......	73	52 200	76 700
FPL	73	54 100	71 200

Correction factor, tensile strength = 54,100/52,200 = 1.038.
Correction factor, flexural strength = 71,200/76,700 = 0.929.
[a] Fabricated by Shell Chemical Co. to be identical with one in Table II.

High-Loading-Rate Strength or Impact Strength

Maxwell and Harrington (**8**) found in their work with poly(methyl methacrylate) on the effect of velocity on tension impact properties that there was no theoretical difference between static and impact phenomena. They showed that high and low rates of loading are related and that the impact test is really only a special case of a "static" test.

There is thus no theoretical reason why very small values of t could not be substituted in the parameter T (20 + log t) to obtain high loading rate strengths. Just as tests at high temperatures are required to determine rupture strengths over long periods of time, tests at low temperatures are required to determine rupture strengths over extremely short periods of time.

Equipment suitable for determining high-loading-rate strengths was being

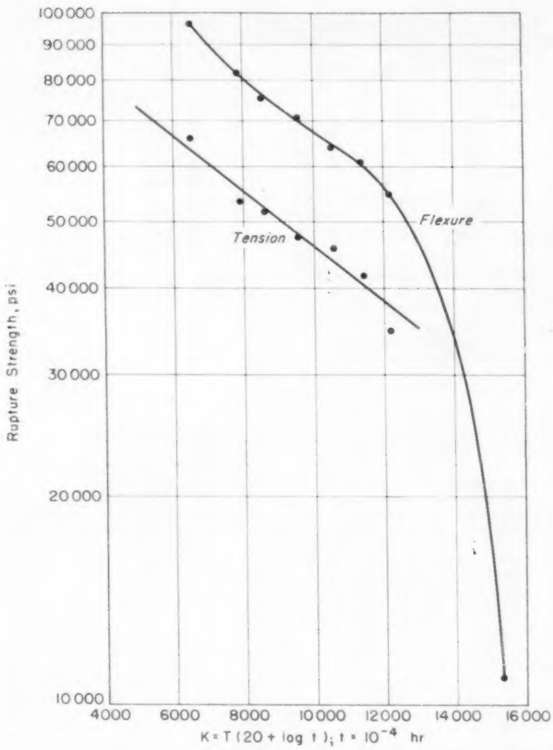

Fig. 2.—Master rupture curves, Epon 828, glass cloth 181, Volan A finish laminate.

period of elapsed time, approximately, the K values should be the same. The tensile rupture strength of the Epon 828 laminate at a K value of 6500 from Fig. 2 is 65,500 psi. Correcting this value by multiplying by 1.038 gives 67,900 psi. The observed value was 68,100 psi.

Results and Discussion

All of the calculated values in both the dry tension and flexural specimens for both long-term and impact conditions were within 7 per cent of the observed results. In the case of the Epon 828 metaphenylene diamine laminate, the parameter was accurate through the complete spectrum of time 0.0113 sec to 20,000 hr—the extent of the test data. Data for this laminate are given in Tables I to IV inclusive. The master rupture curve for tension, Fig. 2, was initially drawn curved, following exactly the points shown. This produced good results until the 10,000 hr time period was reached, when the calculated data began to run strongly negative compared to the observed data. By drawing a straight line while ignoring the last

TABLE IV.—DATA ON EPOXY-GLASS CLOTH LAMINATES.[a]

Temperature, deg Fahr	Temperature, deg Fahr absolute	Tensile Strength, psi	K at 10^{-4} hr
−55.......	405	70 000	6 480
32.......	492	60 600	7 870
78.......	538	57 600	8 580
137.......	597	50 100	9 550
200.......	660	34 400	10 560
250.......	710	26 900	11 360
300.......	760	16 900	12 160

[a] Using Epon 1001 cured with dicyandiamide and reinforced with style 181 glass cloth finished with Volan A.

developed at The Massachusetts Institute of Technology for Picatinny Arsenal (**5**). This apparatus was capable of presenting and recording stress-strain information during a time interval of 5 to 15 milliseconds from the start of loading to fracture. Oscilloscope cameras provided records of strain information. Picatinny Arsenal agreed to test two samples of epoxy laminates which were furnished to them. One of the samples was the Epon 828 laminate being tested at FPL for long-term properties; the other was an Epon 1001 laminate cross-linked with dicyandiamide. These were tested in approximately 0.0113 sec and the values found to be 68,100 psi and 69,500 psi respectively.

Investigation of the impact test apparatus disclosed that the specimen was subjected to a varying load during the extremely short time it was tested. This load was similar to the "static" loading in that the stress increased from zero to a maximum at the point of failure. Thus, although the same master rupture curve (drawn from static rupture test data) could be used, no information was available as to the steady-load-time equivalent of the 0.0113 sec test. Unless this information were known the correct value for t could not be introduced into the parameter.

A reverse procedure was used to obtain these data. The observed tensile impact strength of the Epon 1001 laminate was 69,500 psi. The corresponding K value in Fig. 3 is 6500. Since the Epon 828 laminate was tested at the same temperature and in the same

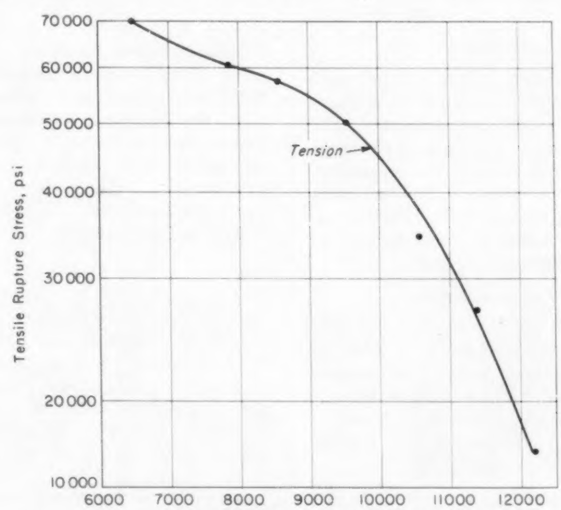

Fig. 3.—Master rupture curve, Epon 1001 and dicyandiamide, glass cloth 181, Volan A finish laminate.

point, excellent agreement was reached up to 20,000 hr, indicating that the straight line was the correct one (6).

Insufficient data were obtained to draw a long enough curve for all the wet strength data. An attempt was made to extrapolate the master rupture curve to obtain an indication of the degree of agreement. In order to secure data for the master rupture curve beyond those obtained, it would have been necessary to devise a special box to treat the specimens with steam at temperatures above 212 F. Since all the specimens had been used and no new ones were obtainable, this was not attempted.

When this investigation was first initiated an attempt was made to derive the SLTE by extrapolating the log time-stress curve backwards in time until the static stress was reached. It was found that the results varied too widely for any conclusion to be made. Some materials were assigned several values of SLTE because the curves had a number of points which were not on straight lines, and all possible variations were taken into account.

Investigation of the slopes of the log time-stress curves showed that the changes in rupture strength per decade of time was about 610 psi in the case of a Selectron 5003 laminate. This represented changes in strength of all materials considered from 2.4 to 7 per cent per decade of time. Some of the materials that were evaluated here have failed in 20 sec while others took as many as 200 sec or more. The difference is in the order of a decade. It would appear that for purposes of comparison all specimens should be caused to fail in the same period of time. This could be accomplished by exploratory tests to determine the approximate strength. The rate of application of load could then be calculated.

It is interesting to note that the SLTE for static stress represents about 0.3 per cent of the actual elapsed time. The SLTE for the impact stress represented about 20 per cent of the elapsed time of 0.0113 sec.

The available data have indicated that it is possible to determine the long-time-rupture stresses of glass-reinforced epoxy laminates. The previous report (3) showed that long-time-rupture strengths of polyester and silicone-glass reinforced laminates could be predicted. In reference (3), tensile and compressive data were considered. In this report, tensile and flexural data were used. Only the tensile impact stresses were determined because of the availability of suitable equipment.

The type of loading considered has been uniaxial. No biaxial data were available. There does not appear to be any theoretical reason, however, why the relationship should not hold for such types of loading. The relationship could not obviously be considered for use with an incompletely cured thermosetting resin, since the conditioning and testing of the material at elevated temperatures would amount to a post cure.

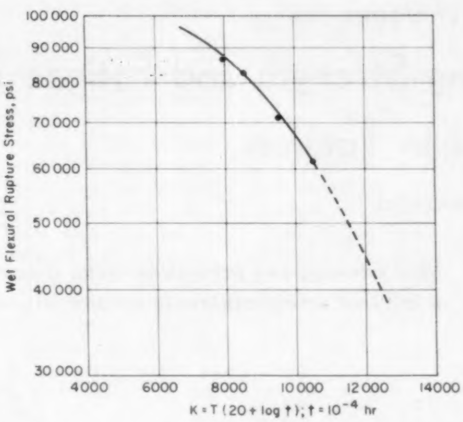

Fig. 4.—Master rupture curve wet flexural strength, Epon 828, glass cloth 181, Volan A finish laminate.

Conclusion

From the results available to date, it is concluded that:

1. The concept of a steady-load-time-equivalent for static stress gave satisfactory results with the parameter $K = T\,(20 + \log t)$ for glass-reinforced plastic materials.

2. Static tests performed in approximately 2 min have been used to calculate results of tests 20,000 hr old as well as tests lasting only 0.0113 sec.

3. The method is applicable to environmental conditions such as loading in a water medium for long periods of time.

Acknowledgments:

In addition to those mentioned in the body of this paper, acknowledgments are made to the following: W. Lawrence and C. Rollins of the ERDL for the testing, R. Winans, New York Naval Shipyard, for providing facilities for high-temperature tests; W. Graner, Bureau of Ships, for providing data from the Forest Products Laboratories; Shell Chemical Co. for supplying laminates; G. Rugger of Picatinny Arsenal for supplying high rate impact data; The Koppers Co. for supplying molded specimens for testing; and the Eastman Chemical Products Co., The Dow Chemical Co., E. I. du Pont de Nemours & Co., Bakelite Co., Monsanto Chemical Co., and the Massachusetts Institute of Technology for supplying data about their products and equipment.

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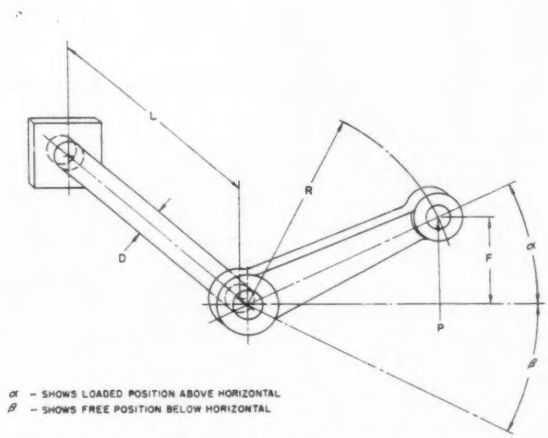
Special Techniques for

Increasing Strength and Fatigue Life of Steel Stressed in Torsion*

By N. E. HENDRICKSON

Shot peening and presetting make it possible for 40 lb of steel in torsion bar springs to do a job that would otherwise require almost twice as much material



Torsion bar spring lever.

THOUGH many metals, including iron and some forms of steel, have been used in industry and the arts for thousands of years, there apparently was no knowledge of the fatigue phenomenon until quite recently. However, during the period between 1859 and 1870, August Woehler, under the auspices of the Prussian Government, worked on a series of experiments to establish the principles of metal fatigue. These were later amplified by Ludwig Spangenberg, whose book *Fatigue of Metals* was published in Germany in 1876.

With characteristic German thoroughness, Woehler and Spangenberg tested, under repeated tension, bending, or torsion stresses, such widely differing materials as wrought iron, cast axle steel, spring steel not hardened, Phoenix iron, Westphalia iron, Firth & Sons Steel, phosphor bronze, common bronze, Krupp's spring steel, and Krupp's axle steel.

At the completion of these experiments, Woehler established the following law:

> Rupture may be caused not only by a force which exceeds the ultimate resistance, but also by the repeated actions of forces alternately rising and falling between certain limits, the greater of which is less than the ultimate resistance. The number of repetitions requisite for rupture are an inverse function both of the variation of the applied force, and of its upper limit.

Thus Woehler stated, possibly for the first time, that fatigue life is dependent on (1) stress range and (2) maximum stress—which principles have since been applied and confirmed countless times in our laboratories and our machines. In fatigue tests on Krupp spring steel in bending, Woehler found that a stress range from 0 to 110,000 psi resulted in breakage after only 40,000 cycles. Every reduction in stress range greatly increased the life, until at a stress range only half as great, that is, from 0 to 55,000, the test specimens were still unbroken after 40,000,000 cycles.

The development of the internal combustion engine and of modern transportation during the twentieth century led to intensive research not only on alloy steels and their heat treatment but also on other processes for the further improvement of their fatigue qualities. Since the weight of important machine members, such as springs, varies inversely as the square of the safe load stress, the importance of processes that make substantially higher working stresses possible can readily be appreciated.

Among such processes perfected within the last twenty-five years are shot peening and prestressing, and in their development, investigators such as John Almen, F. P. Zimmerli, R. L. Mattson, Henry Fuchs, and O. J. Horger, have made outstanding contributions. Prestressing is the application of a controlled overload to produce "permanent set" in members in which the strains vary across the section. It is especially valuable where the loads are of considerable magnitude, but only if applied in one direction.

Prior to the development of torsion bar spring suspensions during World War II, track-type military vehicles were supported by conical volute springs, coiled of flat spring steel. They were extremely difficult to manufacture and to heat treat, and they proved undependable in service. Furthermore, when they did fail by breaking or settling, the flexible track was no longer fully backed up or supported by the wheels, and it took very few miles of operation to put the vehicle out of commission, through breakage of the track itself.

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* Presented at the Second Pacific Area National Meeting in Los Angeles, September, 1956.

The Author . . .

NIELS E. HENDRICKSON, consulting engineer, Laguna Beach, Calif., was for many years vice-president and chief engineer of Mather Spring Co., Toledo, Ohio. He has written many articles on springs, spring suspensions, and other metallurgical subjects.

This paper discusses torsion bar springs, for track-type vehicles. These springs are about 59 in. long and $1\frac{11}{16}$ in. in body diameter, the ends being appropriately upset and splined for anchorage. In the manufacture of these torsion springs, the principles of shot peening and prestressing have been so effectively applied that the springs can operate, without breaking or taking excessive set, through a stress range of approximately 120,000 psi with the maximum stress at the elastic limit prior to shot-peening and presetting. In fact, the fatigue test specifications allow a maximum set of only 5 deg after twisting 50,000 cycles through a 44 deg range, starting at 5 deg and ending at 49 deg. At the 49-deg angle of twist the calculated torsion stress is 135,800 psi, which is the elastic limit, in torsion, of this A8660 steel at its Rockwell C value of 48.

Thus the shot peening and presetting operations have made it possible for 40 lb of steel in the torsion bar to do a job that otherwise would require almost twice as much material, not to mention the larger and heavier anchors and swinging arms, and the difficulty of accommodating such larger parts in the vehicle design.

The torsion bar springs in question are made of Magnaflux-quality A8660 chromium-nickel-molybdenum steel. This is ordered from the steel mill hot rolled to $1\frac{7}{8}$ in. in diameter. After upsetting the ends, the bar is carefully machined all over, and then finish-ground. This removes about 10 lb of the original 50 lb in the raw stock, but it makes certain that any seams or other flaws will be detected.

The bars are hardened in an electric-resistance heater, with high-frequency booster coils at the upset ends. The temperature is measured by an optical pyrometer focused on the middle portion of the bar. The current is cut off automatically and the bar is ejected at the predetermined hardening temperature, based on the steel analysis—usually between 1550 and 1650 F.

The red-hot bar is immediately transferred to a special quenching machine that spins the bar between rollers as it cools in the 125 F quenching oil. After a predetermined time in the spin-quench from 2 to 3 min, the bar is ejected and manually transferred to an oil tank held at 250 F. Here the transformation to martensite is completed, with no danger of cracking the bar.

After a subsequent tempering at about 800 F in a circulating hot-air furnace, the bar is ready for final straightening and hobbing of the splines at each end. Tempered martensite at Rockwell C 48 is desired throughout the section.

Then after shot peening the body of the bar, the presetting operation follows. This is performed in a special hydraulic-powered twisting machine, in which one end of the bar is held in a fixed splined chuck. The other end is held in a similar chuck, which can be rotated under the operator's control to any desired angle. The specification for the bar under study calls for a 75-deg twisting angle, which is about 50 per cent beyond the elastic limit. The "set" after the first cycle ranges between 15 and 20 deg. Repeating the twisting operation to 75 deg may result in another 2-deg set, to a total of 17 deg the next twist may give only $\frac{1}{2}$ deg further set. This twisting or presetting is repeated until no further set occurs; which usually takes from three to six twisting cycles. After the presetting, the splines on each end that are exactly in line are milled off, and this ever after serves as a check on the performance of the bar in service.

In the manufacturing program at Rheem Automotive Co., any finished torsion bar may be picked at random for a fatigue test through 50,000 cycles from 5 deg initial to 49 deg final twist. This 49-deg twist is the torsional elastic limit of the steel before presetting. During the fatigue test the bar is removed from the press that performs the twisting and placed on centers after 500, 1000, 5000, 10,000, 25,000, and 50,000 cycles. The permanent set is recorded in each instance.

During the past four years, the author's company has run 56 fatigue tests on torsion bars, of which 46 bars were routine checks on production from 27 heats of steel. Eight of A8653 steel from the first two heats were rejected because of insufficient hardenability. The remaining 38 bars, all of A8660 steel, met the Ordnance requirement of 5-deg maximum set after 50,000 cycles. Actually, 85 per cent of these test bars developed a set of less than $3\frac{1}{2}$ deg, and many ran between $1\frac{1}{2}$ and $2\frac{1}{2}$ deg at 50,000 cycles.

One test bar settled 4 deg, 59 min at 50,000 cycles, so the run was continued to 76,448 cycles. The set had then increased only 13 min, to a total of 5 deg-12 min, and the Magnaglo inspection showed no signs of incipient failure.

Another bar that showed a 3-deg, 14-min set after 50,000 cycles was continued in the machine to 100,647 cycles, when the set measured 3 deg, 33 min, with no signs of failure.

Still another test bar showed a 2-deg, 39-min set after 50,000 cycles, and the test was continued to 150,000 cycles when the set measured 3 deg, 11 min. This bar finally broke at 163,164 cycles. This was the longest life ever obtained in this program.

To demonstrate that shot peening and presetting are largely responsible for the extraordinary fatigue life of these torsion bars, fatigue tests were also run on bars in which these special operations had been partially or wholly omitted. Tests were run through the usual range, from 5 deg initial to 49 deg final twist, and in each case the machine was adjusted after appreciable set had occurred, to restore the full 44-deg maximum travel.

Torsion Bar Neither Shot Peened Nor Preset

At 1000 cycles the bar showed 5 deg 13 min, which was beyond allowable limits. At 20,000 cycles, the set exceeded 7 deg, and at 23,159 cycles, the bar failed without warning, with the characteristic spiral fracture in the body. Thus at 1000 cycles, or 2 per cent of the required life, the maximum 5-deg set had already occurred.

Torsion Bar Shot Peened, but Not Preset

At 1000 cycles the bar showed 4 deg 44 min set, and at 2500 cycles 5 deg 6 min set. Thus at 2500 cycles, or only 5 per cent of the required 50,000 cycles, the maximum allowable set had been exceeded. This test was not continued to full breakage.

Torsion Bar Preset, but Not Shot Peened

At 10,000 cycles a permanent set of 1 deg, 51 min resulted, which seemed to promise well for the future. However, at 11,147 cycles, this bar broke without warning. It was badly cracked up.

Torsion Bars Preset First, and Then Shot Peened

Three such bars were run to 50,000 cycles, and the set ranged from 3 deg, 36 min to 4 deg, 50 min. However, similar bars of the same heat of steel produced by exactly the same process except that they were shot peened before presetting showed an average set of only 1 deg, 45 min. It is of course logical to shot peen *before* presetting, and these tests definitely proved that it is the best procedure.

In the four years of this program some unusual experiences have developed. For instance, two torsion bars were returned by a customer because they had "unwound" in service. It seems that the right hand bar had been installed in the left hand position, and *vice versa*, and after 200 miles of severe road testing, both bars had lost almost a third of their original preset angle. The preset was restored in the right hand bar, which was then subjected to a fatigue test. At 50,000 cycles the set was only 2 deg, 45 min, and at 150,000 cycles it had increased to 3 deg, 15 min. The bar finally broke at 161,499 cycles, which was a rather

remarkable performance, considering the many things it had endured. Fatigue tests on the left hand bar were not run because the testing machine could not handle it.

Techniques of shot peening and presetting for increasing the fatigue life of highly stressed parts are becoming more and more common. For example, today all automobile suspension springs, both coil springs and leaf springs, are shot peened and preset. Because of the higher stresses thus allowable, the weight of a set of automobile springs is now about half what it was 25 years ago, despite vastly improved riding qualities through higher deflections.

It is remarkable that these two special processes, shot peening and prestressing, can pay such enormous dividends in weight saving and increased life, far in excess of what might reasonably be expected, in view of their comparatively small cost.

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The Strontium Oxide Content of Portland Cements

BY LEONARD BEAN

THE determination of the strontium content of cement may have an important bearing on the question of calculating compound composition and of meeting a specification requirement. As shown by the cements examined and reported here, a few scattered areas of the United States and Europe produce cements with relatively high strontium oxide contents (0.25 to 0.4 per cent). In an earlier paper (**1**)[1], based on work done in this laboratory, Diamond described a flame photometric method for the determination of strontium in portland cement. He presented a figure showing the frequency of occurrence of various percentages of strontium, expressed as the oxide, in 128 cements.

Further work in this laboratory has furnished the strontium contents of 75 additional cements, as determined by the same procedure (**1**). Thus, data showing the occurrence of this constituent are now available for 203 different cements. Six of these are foreign portland cements from Germany, India, Portugal, and Sweden. Five are blast-furnace slag cements, two are portland pozzolan cements, and one is natural cement. The remainder, 189, are domestic portland cements from 123 mills in the United States. Determination of strontium oxide corrects possible errors in calculating compound composition where there is a limit on tricalcium silicate content. It should be emphasized that values given for the SrO content of all the cements are for the SrO found in the hydrochloric-acid soluble portion of the cement. In the cases of portland pozzolan and natural cement, no attempt was made to determine the strontium in the rather large acid-insoluble residue.

In Fig. 1 is shown the frequency of distribution of percentages of SrO in the 75 cements reported in this paper. The pattern is similar to that for the 128 cements previously reported by Diamond. The modal values are 0.05 and 0.06 per cent, the median 0.10 per cent, and the mean 0.12 per cent.

Combining the data for the entire 203 cements gives the frequency of distribution shown in Fig. 2, with a modal value of 0.05 per cent, the median 0.10 per cent, and the mean 0.13 per cent.

The geographical distribution of cements containing the higher amounts of strontium oxide is of some interest. The highest values (up to 0.39 per cent) are in the Lehigh Valley area of Pennsylvania. Cements containing from 0.25 to 0.30 per cent SrO are manufactured in the areas around east-central New York, southeastern Virginia, west-central Alabama, northeastern Florida, eastern Kansas, and northern Colorado. A sample of West German cement contained 0.28 per cent SrO. Less than 0.25 per cent SrO was found in the cements from other areas which were included in this study. A. Van Valkenburg (**4**) pointed out that the areas mentioned above in which the strontium content of the cement is relatively high are known geologically to be areas containing marine fossils. Rankama and Sahama (**3**) mentioned that celestite is very often associated with remains of marine organisms which have originally built shells consisting of aragonite.

As a check on the precision between two chemists using this flame photometric method, the strontium in 4 of the samples reported by Diamond (**1**) was redetermined. He reported values of 0.17, 0.09, 0.04, and 0.05 per cent SrO for these cements. During the course of the further work reported here, values of 0.16, 0.09, 0.04, and 0.05 per cent SrO were obtained for the same cements.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

LEONARD BEAN is a research chemist engaged in development of analytical methods in the Concreting Materials Section, National Bureau of Standards, where he has been employed since 1941. He is author or co-author of a number of papers on cement analysis and was for fifteen years in charge of cement analysis at the Washington laboratory of NBS.

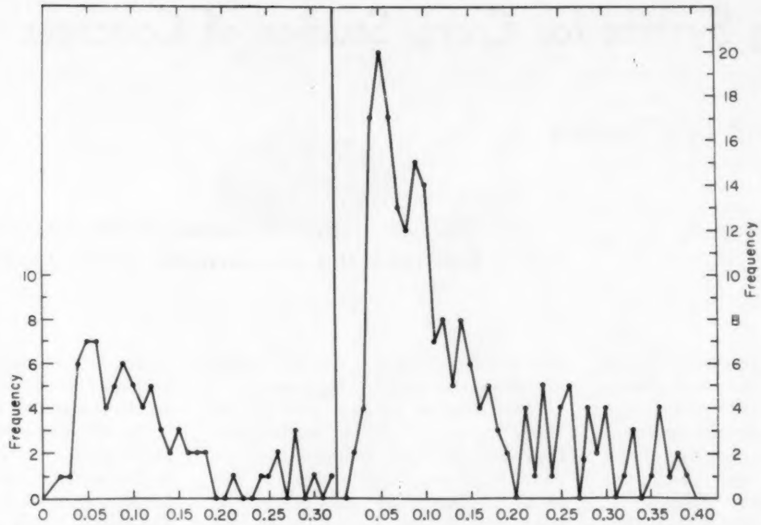

Fig. 1.—**Distribution frequency of percentage SrO found in 75 cements.**

Fig. 2.—**Distribution frequency of percentage SrO found in 203 cements.**

Discussion

The error made in calculating potential[2] composition[3] of the calcium silicates if the strontium has not been determined, and the necessary correction will depend on the amount of strontium present and on the method used for determining the calcium. If the precipitated oxalates have been titrated with permanganate (Section 35 of ASTM Methods C 114[4]), the error is minimized because of the difference in atomic weight between calcium and strontium (40.08:87.63). Any strontium oxalate present is erroneously assumed to be calcium oxalate. The equivalent ratio is

$$\frac{\text{Molecular weight of CaO}}{\text{Molecular weight of SrO}} = \frac{56.08}{103.63}$$

Therefore, the error in reported percentage of CaO will be only 0.54 times the actual percentage of SrO present. If, however, the calcium has been determined by igniting the oxalate precipitate to the oxides (Section 13 of ASTM Methods C 114[4]), then the error in reported CaO percentage will be equal to the percentage of SrO present. Two examples will illustrate:

One sample shown in Fig. 2 contained strontium equivalent to 0.39 per cent SrO (the highest found). When the calcium was determined by permanganate titration the calculated tricalcium silicate values were: correcting for the SrO 48.5+ per cent, not correcting 49.3 per cent. Both round off to 49 per cent for reporting purposes.[5] If the calcium had been determined by ignition to the oxides, the calculated tricalcium silicate values would have been 48.5+ per cent corrected and 50.1 per cent uncorrected, rounding off to 49 per cent and 50 per cent.

Another sample shown in Fig. 2 contained 0.38 per cent SrO. Determination of calcium by permanganate titration gave for calculated tricalcium silicate 51.1 per cent corrected for SrO and 51.9 per cent uncorrected, rounding off to 51 and 52 per cent. If the calcium had been determined by ignition to the oxides, the calculated tricalcium silicate values would have been 51.1 per cent corrected and 52.7 per cent uncorrected, rounding off to 51 and 53 per cent. Thus knowledge of the strontium content of a cement may have a significant bearing on the calculated compound composition.

It might be mentioned that Nurse (**2**) found that using tristrontium silicate in a 1:3 mortar gave cubes that hardened slightly but disintegrated in water. No attempt was made in this investigation to determine the state of combination of strontium in cement.

Conclusions

An error of 2 per cent in reported tricalcium silicate can result if strontium is not determined and the necessary correction made. If calcium is determined by the routine titration procedure, the error caused by failure to determine strontium is minimized.

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[2] Assuming equilibrium conditions during the burning process with complete crystallization and no glass formation.

According to Federal Specification, Cement, Portland, SS-C-192b, July 2, p. 2 (1956), the calculated tricalcium silicate

= (4.07 × per cent CaO) − (7.60 × per cent SiO)
− (6.72 × per cent Al_2O_3) − (1.43 × per cent $Fe^2{}_2O_3$)
− (2.85 × per cent SO_3)

Also according to the same Specification, the calculated tricalcium aluminate = (2.65 × per cent Al_2O_3) − (1.69 × per cent Fe_2O_3).

The same formulae are used in the ASTM Specifications for Portland Cement.[3]

[3] Specification for Portland Cement (C 150–56), Suppl. to 1955 Book of ASTM Standards, Part 3, p. 1.

[4] Methods of Chemical Analysis of Portland Cement (C 114–53), 1955 Book of ASTM Standards, Part 3, p. 69.

[5] The Federal Specification for type II cement carries a maximum limitation of 58 per cent for tricalcium silicate plus tricalcium aluminate. The ASTM Specification for type II cement limits the tricalcium silicate to a maximum of 50 per cent and the tricalcium aluminate to a maximum of 8 per cent.

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A Loading System for Creep Studies of Concrete

By C. H. BEST, D. PIRTZ, and M. POLIVKA

This hydraulic system insures uniform stress distribution over the entire cross-sectional area of a test specimen

As a result of recent developments in the concrete construction industry and the growing tendency toward the use of high-strength concrete, a more complete understanding of the behavior of concrete under high sustained loads is needed. Specifically, these new developments include the use of high-strength concrete in the fields of prestressed concrete, precast concrete structural units, and tilt-up and lift-up construction. The use of lightweight concrete in these fields is becoming more prominent. Also, for reasons of economy, the use of concrete of higher strength in mass construction, especially in arch-type dams, is becoming the practice. It is also expected that the increasing use of high-density concrete for radiation shielding will soon demand more information on its creep characteristics.

In the planning of a series of research projects concerned with creep of such concretes, the authors were confronted with the job of designing a loading system capable of applying and maintaining high stresses over long periods of time. One of these research projects[1] (**1, 2, 3**)[2] was concerned with the evaluation of the creep characteristics of concretes containing lightweight expanded-shale aggregates. The 6-in. diameter concrete specimens of this investigation were to have nominal compressive strengths of 3000 and 5000 psi and were to be subjected to constant, sustained stresses of 1200 and 2000 psi, respectively. In another investigation (**4**)[3] concerned with mass concrete, specimens as large as 30 in. in diameter were to be subjected to a sustained stress of 800 psi (565,000 lb total load).

Creep studies are not new at the University of California in Berkeley. Such investigations, initiated by Raymond E. Davis (**5**), date back to 1925. Many of these creep tests are still in progress, and data of much significance and value have been obtained from them over the past thirty-two years. The specimens in the Davis investigations were all spring-loaded. Spring-loading requires great care in applying the proper initial load as well as in maintaining this load over a long period of time. Also, the application of loads of substantial magnitudes by means of springs becomes too cumbersome to be practical. An example of the complexities encountered in spring-loading a large specimen may be found in a discussion by Herbert F. Cook (**6**) in which he describes the loading frame used by the Corps of Engineers, U. S. Army, Vicksburg, Miss., for the application of a stress of 300 psi to a 30 by 60-in. concrete cylinder.

To simplify the application of constant loads over long periods of time and to permit the use of higher sustained loads, a hydraulic system was developed. Contained herein are the details of this system along with a description of the loading frames used by the authors for creep studies of concretes employing specimens having diameters of 6, 16, and 30 in.

The Loading System

In the design of the loading system, the authors were guided by the requirements of (*a*) developing and maintaining a constant known stress over any desired range of magnitude, (*b*) keeping maintenance to a minimum and avoiding subsequent manual adjustments, and (*c*) making loading frames as light as possible while insuring a uniform

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[1] Supported by the Institute of Engineering Research, University of California, Milos Polivka, faculty investigator.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

[3] Supported by the Institute of Engineering Research, University of California, David Pirtz, faculty investigator.

distribution of stress over the entire area of specimen cross-section.

These requirements were fulfilled by the use of a simple hydraulic cell in conjunction with an electronically controlled pressure supply system and appurtenant equipment as here described.

Hydraulic Loading Cell

The loading cell developed consists essentially of a shallow steel cylinder containing a molded rubber piston cup supporting a steel plate. Figure 1 shows an expanded view of one such cell. This particular cell was designed to be used in connection with the creep studies on concrete specimens only 6 in. in diameter. Cells of larger diameter, which required special consideration, are described later.

The pressure which activates the cell is supplied by an electronically controlled hydraulic pump. With constant pressure maintained in the cell, a constant load will be applied through the plate to the specimen bearing on it provided the rubber piston cup does not "freeze" in the cylinder. To check this possibility, a proof test was conducted. This test consisted in measuring accurately the load transmitted by the cell, maintained at constant pressure, to a concrete specimen undergoing volumetric changes due to drying shrinkage and creep over a period of six months. The cell pressure was measured by means of a calibrated laboratory-type Bourdon-tube pressure gage. The load transmitted to the specimen was measured by means of a special calibrated device consisting of a Carlson strain meter (**7**) mounted inside a carefully machined tube. Figure 2 shows the proof test rig consisting of the loading cell mounted between a 6 by 12-in. concrete cylinder and the special Carlson load-measuring device in the loading frame. With a stress of 1000 psi sustained for six months, there was no measurable change in the magnitude of the load on the specimen. This result indicates that the rubber piston cup has no tendency to freeze in the cylinder.

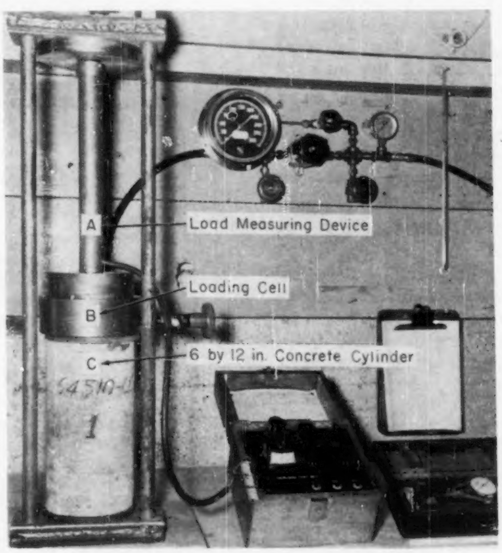
During the proof test just described, a slight leakage of hydraulic fluid (SAE 30) between the cylinder and the cup was observed. Perhaps this leakage was beneficial in preventing the cup from freezing. Because of this slight leakage, it is desirable to install such a cell at the lower end of a test specimen, if possible, to prevent the oil from getting in contact with the concrete. It might also be desirable to include provision for collection and disposal of this oil. The use of a completely sealed cell was also considered and might be worth investigating. However, it is felt that the simplicity of the cell employed more than offsets any inconvenience caused by the slight oil leakage.

Fig. 1.—Hydraulic loading cell for 6-in. diameter concrete cylinder.

Pressure Supply and Control System

The pressure supply and control system posed a major problem. In the first pilot test of the loading cell, pressure was supplied from a commercial nitrogen bottle through a small-volume regulator which reduced the bottle pressure to the desired value. This pressure supply system proved unsatisfactory because (1) working pressures were necessarily lower than the initial charge in the bottle, (2) proper operation of the regulator required a small but continuous flow of gas, making frequent bottle replacements necessary, and (3) substantial monitoring was required in order to maintain loads within desired limits. The nitrogen system was therefore abandoned.

Efforts were then directed toward the development of the hydraulic pressure supply and control system shown schematically in Fig. 3. The required oil pressures for the operation of the loading cells are developed by means of an American Bosch diesel fuel-injection pump powered by a $\frac{1}{20}$-hp ratio motor capable of developing 21 in.-lb of torque at 57 rpm. Oil is supplied to the pump from a reservoir of capacity sufficient to eliminate frequent monitoring. The primary reason for the selection of a fuel-injection pump was its low displacement and high-pressure capacity. Such a pump delivers about one drop of oil per stroke and develops a working pressure of 2000 psi readily. With a pump of such small displacement, pressure control is a relatively simple problem because surcharges do not occur. This control was achieved by activating the pump motor with a Minneapolis Honeywell vane-type electronic pressure regulator sensitive to small decreases in line pressure. The desired pressure is simply preset on the regulator which, in conjunction with the injection pump, will maintain that pressure within 0.1 per cent. In case of failure within the controller, for example, a burned-out vacuum tube, power to the pumping



A—Load Measuring Device, B—Loading Cells, C—6- by-12 in. Concrete Cylinder

Fig. 2.—Proof test assembly.

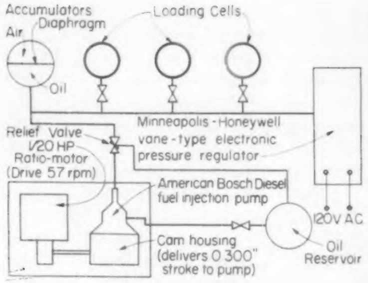


Fig. 3.—Typical pressure supply and loading system.

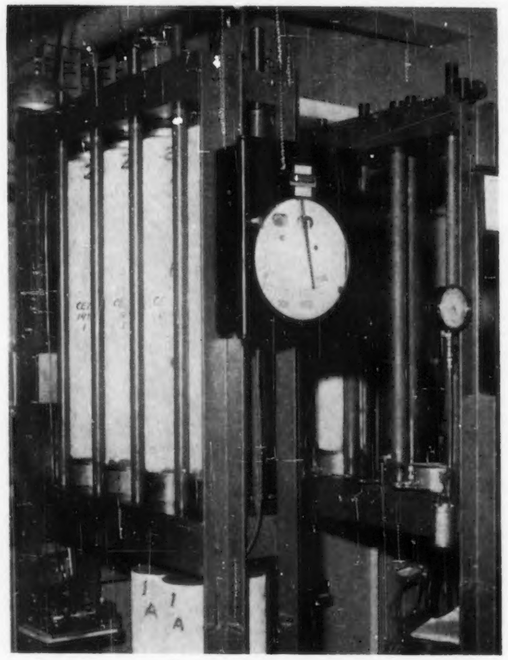


Fig. 4.—Installation for loading 6-in. diameter concrete creep specimens.

unit is shut off automatically. To prevent substantial loss of pressure due to controller or power failure, an accumulator is included in the system. The accumulator used is of the type designed to absorb shocks in the landing gear mechanism of heavy aircraft. This accumulator has two compartments separated by a flexible diaphragm. One compartment is initially charged with a gas at a pressure slightly below the desired operating pressure; the other compartment is connected to the oil system. Besides insuring against pressure drops during a power failure, the accumulator acts as a surge tank.

Figure 4 shows a typical installation presently being used for loading concrete creep specimens 6 in. in diameter. All specimens subjected to the same stress are grouped together and are serviced by a single pressure supply and control system. One of the advantages of group loading is that there can be no question of unequal loads on specimens used for purposes of comparison. Similar group loading is being employed in another of the authors' studies even though the specimens of 6, 16, and 30-in. diameters are installed in separate frames. This grouping is accomplished simply by connecting the individual loading cells, regardless of size, to a common pressure supply and control system. Both $\frac{1}{8}$-in. standard steel pipe and $\frac{1}{8}$-in. standard copper tubing were used successfully for making all necessary hydraulic connections. Copper tubing was found to be more satisfactory because of its flexibility. Certain connections were made advantageously with high-pressure flexible hose.

Other Applications

After the completion of the development of the loading system for the 6-in. diameter concrete specimens, the authors were confronted with the additional problem of the design of loading frames for specimens 16 and 30 in. in diameter to be subjected to a stress of 800 psi. Deflection in the end plates of such loading frames might be of sufficient magnitude to cause an unacceptable nonuniform stress distribution in the concrete. In the loading frame for a concrete specimen 30 in. in diameter used by the Corps of Engineers (6), it was found necessary to increase the thickness of the build-up steel end plates from 5 to 10 in. in order to avoid excessive deflections under a sustained stress of only 300 psi. Therefore, the authors decided to employ a stress-equalizing cell of the type used in the Carlson stress meter (8) (Fig. 5, detail B at one end of the specimen to eliminate this condition. The problem of uniform load distribution is automatically solved at the other end of the specimen by the loading cell. The details of the frame adopted for the loading of the 30 by 60-in. concrete specimen are shown in Fig. 5. The stress-equalizing cell, which is fitted with a pressure gage, also provides a check on the action of the piston cup in the upper plate. Any tendency of the cup to freeze would be manifested by a drop in pressure in the stress-equalizing cell. Periodic observations for more than nine months indicate that a constant stress is being applied to the specimen within 1 psi. There can be no question that the loading cells regardless of size, are functioning satisfactorily.

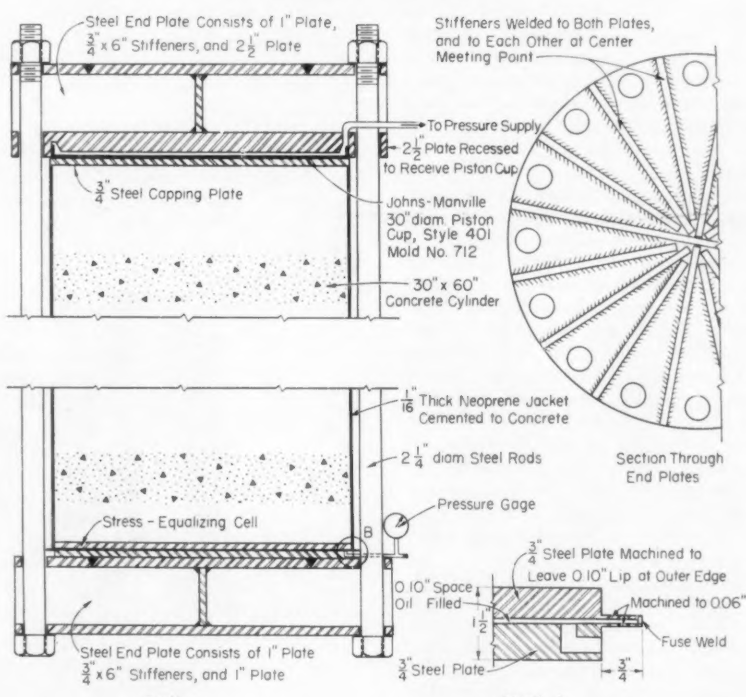


Fig. 5.—Loading frame for 30 by 60-in. concrete cylinder.

In the loading frames for the 16-in. specimens, it was considered more economical to use a solid steel plate of sufficient thickness rather than to use a stress-equalizing cell. Figure 6 shows the details of such a loading frame. Bolts were located so that Whittemore strain gage measurements could be made on three vertical lines spaced 120 deg apart. Consequently, the top plate of each frame was made trapezoidal to save material. The hydraulic loading cells for both the 16- and 30-in. specimens were incorporated into the upper loading plates to avoid the necessity of providing separate units as for the 6-in. specimens. Figure 7 shows an over-all view of these sizes of specimens (16 and 30-in. diameter) used in the mass-concrete creep study. The loading cells for these specimens are again all activated by a single pressure supply and control system operating at 800 psi.

Conclusions

The loading system herein described provides a practical means of applying to concrete specimens even of large sizes, constant, uniform, sustained compressive stresses of large magnitudes which were previously difficult, if not impossible, to attain. The number of specimens which may be subjected to the same stress simultaneously by a single pressure supply and control system is unlimited. Experience to date indicates that this system is extremely precise and reliable and that it operates with practically no maintenance.

Acknowledgments:

The authors gratefully acknowledge the invaluable assistance contributed to the development of the loading cell by Jerome M. Raphael. In addition, acknowledgment is given to Norman E. Haavik who was responsible for mechanical design, and to A. D. Lawrence who was responsible for some of the design, production, and assembly of the equipment.

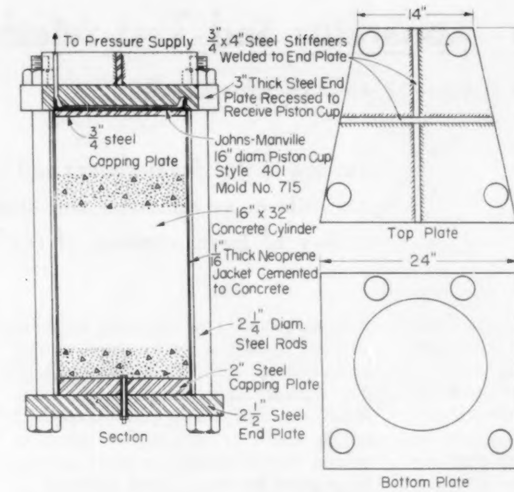


Fig. 6.—Loading frame for 16 by 32-in. concrete cylinder.

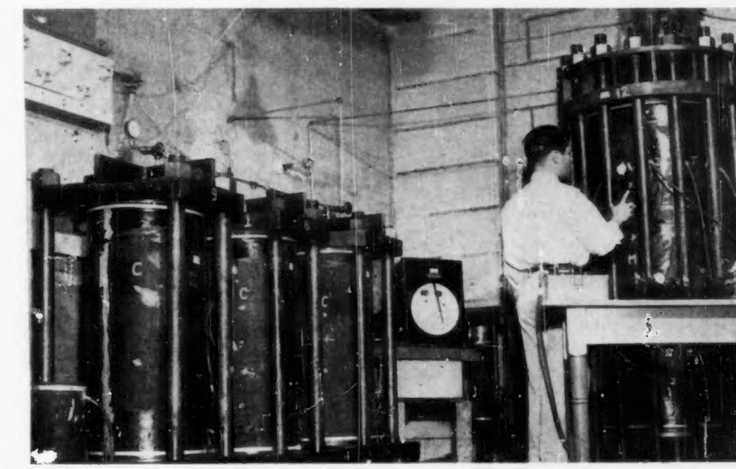


Fig. 7.—16-in. (left) and 30-in. (right) specimens used in mass concrete creep study.

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Ice Adhesion Apparatus and Test Method*

By HYMAN LACKS, MAX QUATINETZ, and ARNOLD FREIBERGER

For use in the development and evaluation of coatings to which ice has little or no adhesion, this apparatus provides capacity for routine testing of large numbers of test panels with good reproducibility

ICE formations on decks and super-structures of Naval vessels often make them unseaworthy, and render their guns, radar, and other operating equipment, to a large degree, unworkable. The present advance into the Arctic for military and commercial purposes and the establishment of regular polar flights point up the necessity for research in combating the hazards of icing.

The current practices employed for combating the effects of ice are:

(*a*) Manual and mechanical means such as mallets, rubber boots, grinding, and chopping machines.

(*b*) Freezing point depressants as dispensed by slider rings on aircraft propellers and by leaching out from coatings.

(*c*) Parting compounds such as silicone grease, petroleum jelly, or oils which are removed with the ice.

(*d*) Thermal systems using electrical surface heating, induction coils, exhaust gases, steam, hot water, and glass bead paints that absorb infrared rays.

The ultimate solution to the problem lies in the creation of a durable coating to which ice will not adhere. No such coating has yet been made although efforts are continuing in this direction. The authors have been working on the development of such a coating by attempting to modify the standard Navy shipboard deck paint to make it icephobic.

The first step in pursuing such a study involved the development of a suitable apparatus and test method to measure the force of adhesion of ice to various surfaces. Review of the literature on apparatus and methods for determining adhesion of ice to a surface indicated lack of duplicability of reported ice adhesion values from similar surfaces. Known methods for releasing ice from surfaces include a tension method (**3**)[1] and various shear methods (**1,2,4,5**). The authors have designed an ice adhesion shear apparatus and test method to provide for repeatable adhesion values, ease of operation, and capacity for routine testing of large numbers of test panels.

Apparatus and Test Method

The apparatus is illustrated in the schematic representations in Figs. 1 and 2. The apparatus is used to measure, under specified conditions, the adhesion of ice to a surface in terms of the stress required to shear the ice horizontally from the surface. Essentially the apparatus consists of a temperature regulated refrigerated chamber, in which specimen panels are mounted rigidly on a base plate of stainless steel. Water is frozen in three ice holders that rest on each of the specimen panels. Wire ropes which pass through small openings in the front wall of the chamber are used to pull the ice holders. The specimen panels are $7\frac{1}{2}$ by 2 by $\frac{1}{4}$ in. thick and are notched at their ends to permit firm attachment to the base plate by means of wing nuts. The ice holders are square, measuring 1 by 1 in. inside, with the wall $\frac{1}{2}$ in. high and $\frac{1}{32}$ in. thick, and are provided with a yoke to which the wire rope can be attached. The lower edges of the ice holder walls have been ground flat. The wire rope is connected to a pulling mechanism, which consists of a geared motor connected to a shaft that rotates at $\frac{1}{2}$ rpm. The pulling load, which is noted on a scale tied into the wire rope, is increased at the rate of 3 lb per sec. The chamber has an inside volume of about 4 cu ft and is maintained at a temperature of 10 F ± 2 F. The base plate is designed to accommodate ten panels at one time (Fig. 3).

The following operating technique is employed:

(*a*) Mild steel specimen panels are carefully cleaned by sandblasting, emery polishing, solvent rinsing, and air blast drying. The panels are demagnetized and electrically grounded before ice is formed on them.

(*b*) The coatings are applied by brush or spray to one side of the specimen panels.

(*c*) Coatings are allowed to dry thoroughly before having ice formed on them.

(*d*) The panels, with the ice holders resting on them, are then bolted down to the base plate in the ice adhesion apparatus, which is maintained at 10 F. After 1 hr at this temperature, 6 ml of distilled water, in equilibrium with ice, are poured into each ice holder.

(*e*) The ice is allowed a minimum of 2 hr to form and reach the 10 F temperature of the apparatus before it is sheared from the panels.

In order to determine the reproducibility of test results and the experimental error involved in the use of the ice adhesion apparatus, tests were run with 12 mild steel panels. The results are shown in Table I. By an appropriate analysis of variance, the uncontrolled experimental error was calculated to be 11 per cent of the over-all average of 132.4 psi. Differences due to position of the ice blocks on the panels were insignificant, while differences among panels amounted to 6 per cent of the over-all average. Note that 64 per cent of the values fell within 12.5 psi (9.4 per cent) of the 132.4 average, that is, between 120 and 145 psi.

Similar ice adhesion tests were made on mild steel panels that had been coated with the Navy gray deck paint described by joint Army-Navy Specification JAN-P-699. The average ice adhesion on this paint measured 85 psi, and the calculated error was 13 per cent.

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* The opinions and assertions expressed in this paper are the authors' and are not to be construed as official or reflecting the views of the Navy Dept. or the Naval Service at large.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

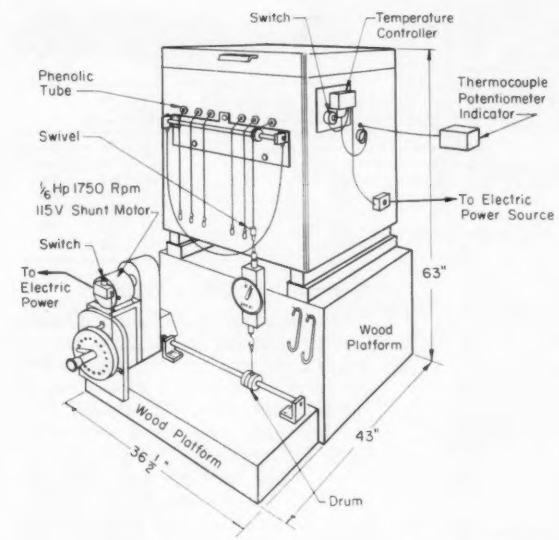

Fig. 1.—Material Laboratory ice adhesion apparatus.

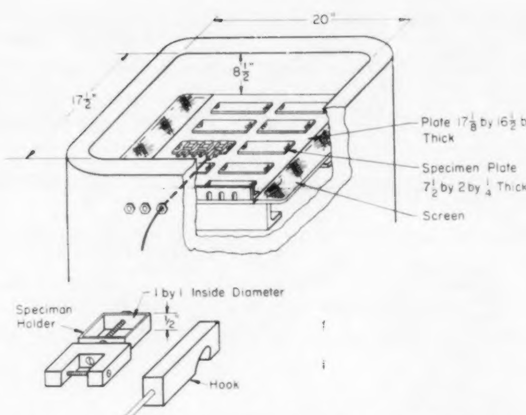

Fig. 2.—Interior view of Material Laboratory ice adhesion apparatus.

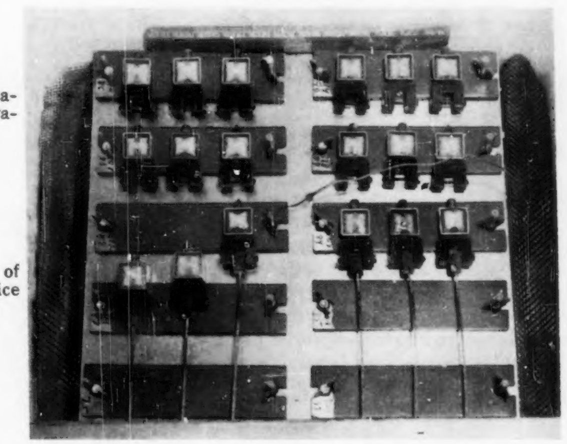

Fig. 3.—Interior view of Material Laboratory ice adhesion apparatus.

TABLE I.—ADHESION OF ICE TO MILD STEEL.

Panel	Adhesion, psi		
	Position No. 1	Position No. 2	Position No. 3
No. 1	154[b]	90[b]	144
No. 2	132	128	130
No. 3	126	138	[a]
No. 4	96[b]	120	100[b]
No. 5	140	120	[a]
No. 6	126	162[b]	[a]
No. 7	166[b]	142	152[b]
No. 8	130	150[b]	116[b]
No. 9	138	136	130
No. 10	130	136	[a]
No. 11	138	134	140
No. 12	140	124	120

[a] Ice holders fell off while handling during tests.

[b] Values differing from average by more than 9.4 per cent.

Discussion

Consideration was given to the following factors in the development of the apparatus and test method:

Impurities

Attention was directed toward keeping the coatings or surfaces against which ice was formed reasonably free from contamination during preparation, storage, and use. It is equally important to keep the air in the test area free of contaminants such as water-soluble gases or vapors which have been found to have a marked effect on the ice adhesion.

Humidity

Exposure of coated surfaces to different humidities was found to cause variations in the ice adhesion results, generally the longer the exposure and the higher the humidity the higher the adhesion values obtained. For the investigative work involved in this type of study, it is desirable that the temperature and humidity conditions in the test area be controlled and standardized so that the work is conducted at fixed conditions.

A temperature of 70 F, a relative humidity of 50 per cent, and a test panel storage time not to exceed 5 days between the end of the drying period and the formation of ice are considered suitable for this purpose.

TABLE II.—ICE ADHESION AND RATE OF FREEZING ON MILD STEEL PANELS.[a]

Freezing Temperature, deg Fahr	Pulling Temperature, deg Fahr	Time of Freezing, min	Ice Adhesion, psi			
			1	2	3	Average
15.......	10	33	72	95	81	83
26.......	10	75	134	133	129	132

[a] Data were obtained using a larger cold box of higher heat capacity in which a freezing temperature of 26 F is normally employed. The ice once formed is sheared at 10 F. This procedure gives values equal to those obtained in the box shown in Fig. 1.

TABLE IV.—ICE ADHESION AND RATE OF FREEZING ON NAVY DECK PAINT ON MILD STEEL PANELS.[a]

Freezing Temperature, deg Fahr	Pulling Temperature, deg Fahr	Ice Adhesion, psi			
		1	2	3	Average
+26.......	+10	..	..	..	85
+26.......	−20	132	109	96	112
−25.......	−25	60	68	56	61
−25.......	+25	49	42	54	48

[a] Data were obtained using a larger cold box of higher heat capacity in which a freezing temperature of 26 F is normally employed. The ice once formed is sheared at 10 F. This procedure gives values equal to those obtained in the box shown in Fig. 1.

TABLE III.—ICE ADHESION AND RATE OF FREEZING ON NAVY DECK PAINT ON MILD STEEL PANELS.

Freezing and Pulling Temperature, deg Fahr	Ice Adhesion, psi			
	1	2	3	Average
+30............	104	88	91	94
+15............	97	94	94	95
0............	84	70	84	79
−20............	77	84	64	75
−30............	59	72	52	63

Electric or Magnetic Condition of Panel

Grounding and demagnetizing of steel panels before use has been found to give more uniform ice adhesion values.

Rigidity

Thin panels of steel were found to give low ice adhesion values due to stress concentrations caused by the buckling and flexing of the panels. Quarter inch plate thickness was found sufficient to prevent flexing. In addition, it was found necessary to clamp the panel securely to a rigidly mounted base plate. The sample panel should be straight and not warped so that clamping will not flex it.

Vibration

Vibration should be held to a minimum by use of suitably designed refrigerating equipment.

Alignment of Ice Holders

The ice holders were aligned so that the pull wire was perpendicular to the holder. Swivels were incorporated into the pull wire so that no twisting could occur.

Water

Distilled water used to form the ice in the ice holders on the specimen panels was poured from a mixture of approximately equal proportions of ice and water in equilibrium at 32 F. No ice is permitted to fall into the holders during pouring. This mixture was used since it was found that the adhesion values were higher when ice was present in the water at pouring. The 6 ml of ice water were poured gently and in one continuous operation into the holder to avoid splashing. The use of less than 6 ml of water did not permit the holder to grip the ice block adequately.

Rate of Freezing

Tests indicated that ice adhesion values were affected by the rate of freezing of the water. This was also noted by other investigators (**1**,**5**). Experiments were performed at the Material Laboratory wherein variations were made in the temperatures of the water, the freezing temperatures, the heat mass of the apparatus, and the types of surfaces used. Results of some of the tests made in this connection are given in Tables II-IV showing that:

(*a*) The higher rates of freezing, as indicated by the shorter freezing times or by the lower freezing temperatures, resulted in lower ice adhesion values, whether on the mild steel panels or on the paint coatings on the mild steel.

(*b*) Lowering the temperature of the ice-metal systems or ice-paint-metal systems after freezing raised the ice adhesion values.

(*c*) The ice adhesions found on the steel panels were greater than on the paint coatings over the steel panels.

Rate of Pulling

The rate of pulling of the wire was set for approximately 3 lb (scale reading) per sec, which is near the slowest rate of the apparatus. Rates higher than 5 lb per sec gave lower ice adhesion values.

Supercooling

When freezing water in the ice holders, supercooling occurred very infrequently. In the instances where this did occur and crystallization was induced, the ice adhesion was not significantly changed.

Shock

The significance of shock can best be seen in the data of Table I wherein the four blanks appear in the last column. Since the pulls were made in order of positions 1, 2, and 3, the ice block in position 3 was subjected to the shock of the first 2 releases of ice from the panel.

Spread of Ice Adhesion Values

Consideration of the factors influencing ice adhesion, particularly rate of freezing, indicates that the magnitude of the adhesion of ice to a surface can be varied considerably. The conditions of the test have been fixed to produce highly adherent ice which gives ice adhesion values near the maximum possible for a given material. With other types of apparatus and test methods, lower results have been obtained with the same materials. It is considered advantageous to set the test conditions to obtain high values so as to produce a large spread in the results obtained for different materials and thus permit a greater degree of accuracy in the determination. Also, these test conditions more nearly simulate the most troublesome conditions which may be met with in nature and therefore increase the probability of predicting good performance in service.

Conclusion

The authors, in designing the ice adhesion apparatus and method of test described herein, have intended to provide a method for determining ice adhesion wherein the variables involved in the required measurements can be suitably controlled for pursuing the development and evaluation of ice-phobic coatings.

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Direct Optical Methods of

Fiber Identification and Brush-Knot[1] Composition Determination

By ERNEST F. FULLAM AND DOUGLAS S. HALLGREN

Two simple methods are proposed for an accurate quantitative determination of the horse hair and hog bristle composition of a paint brush-knot

THE increasing difficulty of obtaining an adequate supply of the superior imported hog bristle for the manufacture of the better grades of paint brushes has, in many instances, led to the adulteration of the paint brush-knot with horse hair. The existence on the market of a substantial quantity of such contaminated brushes has indicated the necessity for a simple, inexpensive method for determining accurately the percentage composition of a brush-knot. Experienced individuals in the trade, using the "eye and feel" test, can quite reliably detect the presence of contaminating horse hair in a brush-knot, although only a rough indication may be obtained by such a method of the percentage composition of the two fiber types. Therefore the necessity of proving the presence of contaminating horse hair to the uninitiated and providing an accurate figure of the fiber type percentage composition by weight of the brush-knot has led to a thorough investigation of methods to differentiate the fiber types.

The literature contains a number of excellent references pertaining to methods of fiber identification. Newman (**1**)[2] proposes a technique whereby the characteristic distribution of pigmentation in the bristle and horse hair may be employed very effectively through use of thin cross-sections of the fibers. As the method is, of course, destructive to the fibers, it cannot be used for weight percentage composition measurements.

Since these two fiber types are identical chemically and have very similar physical and optical properties, their differentiation by a nondestructive method is not easy. The fiber surface scale structures as described by Wildman (**2**), Von Bergen and Krauss (**3**) and others has suggested a possible approach to the problem. An investigation in this laboratory of the differences in scale sizes and structures on the two fiber types has indicated these criteria to be the most feasible characteristics to employ for fiber identification.

As Krauss (**4**), Cocks (**5**), and others at the Battelle Memorial Inst. have pointed out, and as has been confirmed in this laboratory, there are always more scales, in a given fiber length, on hog bristle than on horse hair. Horse hair fibers show 100 to 150 scales per mm and hog bristle 220 or more per mm. Since, as Cocks has pointed out, there is no overlap in the number of scales per mm on the hog bristle and horse hair fibers, there is little chance for confusion in their identification. Briefly the procedure employed at Battelle consists of selecting six completely mixed samples of 500 fibers and preparing a marked plastic replica of each fiber surface. These replicas are shadow cast in a high-vacuum evaporator, with gold at a low angle, to make visible the scale structures. The replicas are examined under a light microscope with an oil immersion lens at a very high magnification with transmitted light, and at least 200 scales counted along the length of the replica. The identified replicas are matched with their corresponding fibers, which are isolated for weighing. Although the method has very good accuracy, it is obviously very slow and requires skills and equipment not found in most small laboratories.

Experimentation

In the search for a relatively simple method for the fiber identification of a brush-knot which would equal the accuracy of the Battelle method, we have devised two optical methods which employ direct observation for comparing the scale structure. To employ the very characteristic features of fiber scale size and structure in any method of fiber identification, it is obviously essential to use only very clean fibers which will clearly show the

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D. S. HALLGREN, microscopist, Ernest F. Fullam, Inc., has for some time been interested in the identification of materials by microscopic and X-ray techniques, an interest which started while formerly employed at the General Electric Research Laboratory. For the past several years he has been working on the development of the techniques described in the paper.

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[1] A brush-knot, as defined by the American Brush Manufacturers Assn., is the total amount of filling material or fibers, of any type, mounted in the ferrule of a brush.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

scales along the major portion of the fiber length. As pointed out by Cocks (**5**), many fibers have an unidentified contaminating layer which hides much of the scale structure, and this layer may be removed by agitation of the fibers in a detergent solution. Our work has confirmed this, but many types of fibers require a more drastic washing procedure than that suggested by Cocks.

The procedure that is followed is to select at random approximately 500 fibers from a thoroughly mixed sample and immerse them in a very hot, strong detergent water solution, and allow them to remain in the solution for a number of hours—preferably overnight. It appears that most household detergents are quite suitable. While still wet, the fibers are individually drawn twice in each direction through a wad of cotton wet with the solution and held firmly between the fingers but not so tightly as to break the fibers. The fibers are then placed in clean hot water and washed with several changes, followed by a rinse with distilled water. Upon drying, six or eight fibers at a time are spread out on a lantern slide cover glass to facilitate manipulation and placed under the light microscope.

Fig. 1.—Schematic diagram for vertical dark field illumination.

Method I

The conventional methods of direct specimen illumination at any magnification do not reveal surface scale structures due to inadequacy of illumination such as specular reflections, or flooding. However, by employing the optical system shown in Fig. 1, together with a double sector illumination diaphragm, the scale structure of the opaque fibers may be clearly observed, as illustrated in Figs. 2 and 3, of hog bristle and horse hair, respectively. This type of optical system provides vertical dark field illumination with the sector diaphragm so placed as to prevent any light from striking the sides of the fiber, thus preventing reflections and

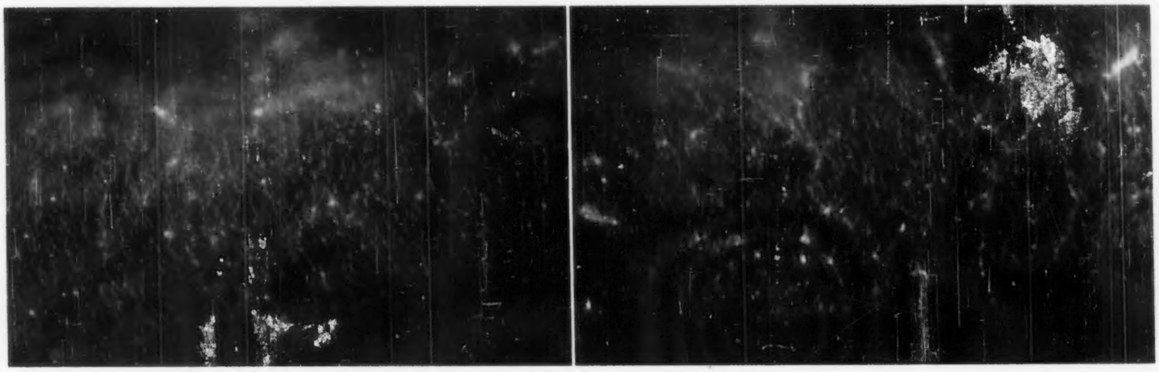

Fig. 2.—Typical hog bristle. (×300) Vertical dark field illumination with double sector diaphragm.

Fig. 3.—Typical horse hair (×300) Vertical dark field illumination with double sector diaphragm.

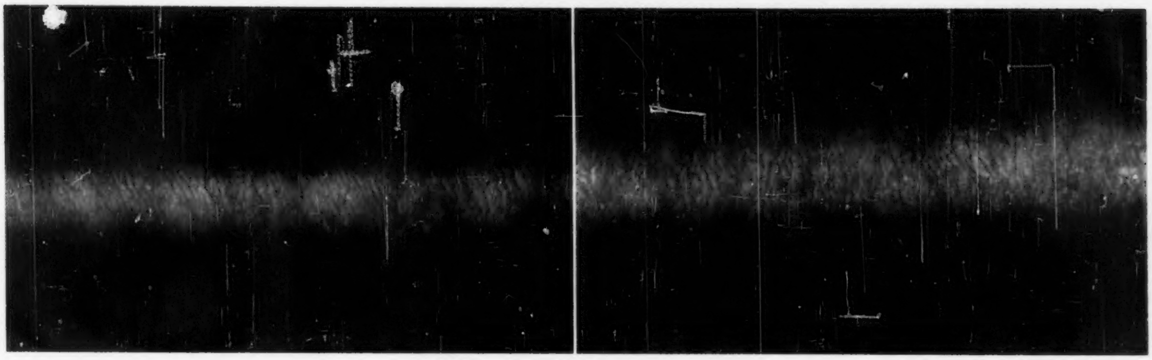

Fig. 4.—Typical hog bristle (left). Typical horse hair (right). Transmitted bright field illumination (×300).

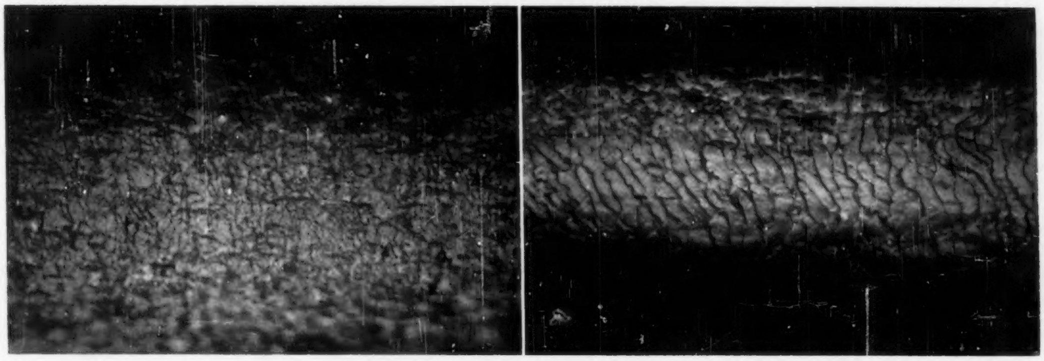

Fig. 5.—Typical hog bristle (left). Typical horse hair (right). Vertical bright field illumination (×300).

flooding (**6**). As strong a light source as is practical should be used, and a total magnification of 200 to 300 diameters is adequate to observe and count the scales on all fibers on which they are present. A 22× objective and a 9× wide field eyepiece are quite suitable.

Translucent fibers scatter so much light under this optical system that it is difficult to observe scale structures. However, this difficulty may be overcome by immersing the fibers in a hot, concentrated basic fuchsin dye in water solution, following the washing procedure, and observing the scales with a dark blue filter. An alternate method of observing the scales on translucent fibers is to employ axial transmitted illumination with the same objective as used in the vertical dark field illumination (Fig. 4). An arrangement should be made so as to be able to shift quickly from one type of illumination to the other depending on the opacity of the fiber being observed.

Method II

Another method of observing fiber scale structures directly is to employ vertical bright field illumination (**6**). Light flooding and specular reflections are eliminated by the use of an external condenser, aperture diaphragm, and center dark field stop. Sufficient light passes this system at the correct angle of incidence to reveal the scales. The system works equally well with both translucent and opaque fibers at the same magnification as used with dark field illumination method. With this method, the scale faces are bright and the edges appear as black lines (Fig. 5).

Discussion

An operator using either optical system must practice with known fibers so that the characteristic features of the relative scale size, contrast, shape, and structure on both hog bristle and horse hair may be easily recognized on unknown fibers. The photomicrographs of characteristic hog bristles (Fig. 2), made by vertical dark field illumination and sector diaphragm, show closely spaced scale edges represented by light lines. The edges are irregular and broken, with many intersections or overlapping of two or more edges in any one field. The scale edges on the horse hairs (Fig. 3) are more widely and evenly spaced, straighter, and more continuous around the fiber with fewer edge-line intersections. However, some types of horse hair have scale edges that are very irregular, but the average wider spacing of the edges serves to identify the fiber.

As the cleaned fibers are moved individually into the field of the objective, simply a glance at one or two areas is usually sufficient, with a little practice, to identify the fiber by its scale edge spacing and structure. However, when widely varying spacing or irregular scale edges are observed, at least four or five areas, selected at

random along the length of the fiber should be examined. If any doubt remains as to its identification, the number of scales per unit length of the fiber may be counted using a mechanical stage and a cross-hair eyepiece, or, preferably, a filar micrometer eyepiece in a manner similar to that employed in the Battelle method with replicas. Fortunately very few fibers have been found that require such measurement for identification. However, the direct observation method of fiber identification is additionally valuable because the Battelle method of scale counting may be used directly on the fibers to improve the accuracy of brush-knot composition determination where necessary. Any fibers that do not clearly show the scale structure because of contamination or mutilation, or other types of fibers that have no scales, must be set aside for rewashing, or discarded.

Mutilated or abraded fibers invariably have at least one limited area in which the scale structure may be observed, to identify the fiber. However, the location of such isolated, untouched areas may require the scanning of the major portion of the fiber surface. If this scanning is carefully done, the number of discarded, completely unidentifiable fibers may be held to a small fraction of a per cent of the total sample.

Upon identification of a fiber, it is placed in the appropriate pile of either hog bristle or horse hair for weighing, as the composition of a brush-knot is usually expressed in percentage by weight. Brush-knot composition measurements made on several samples of fiber mixtures indicate an error of about ± 2 per cent without taking precautions to count the scales on the doubtful fibers or rewashing the very badly contaminated fibers.

Summary

Employing the characteristic differences of scale size and structure between hog bristle and horse hair, two optical systems have been devised whereby the scale structures may be observed directly on the fibers at a low magnification. As no fibers can be identified unless the scale structure is clearly visible, a detergent washing technique suggested by Cocks (**5**) has been improved to the point where contaminating layers are removed more completely to reveal the scales. Using either vertical dark field with axial transmitted or vertical bright field illumination with the necessary auxiliary lenses and diaphragms in both systems, the relative scale edge spacings and structures on most of the fibers may be compared quickly for identification of the fibers. It is important, however, that no attempt be made to identify the fiber unless the scale structure is clearly seen. The few doubtful fibers found may be identified by counting the scales in a unit length directly on the fiber in a manner similar to that employed in the Battelle method on replicas.

The equipment used in either of the two direct optical methods is relatively inexpensive, may be used effectively by an inexperienced person, and, most important, does not cause undue eye fatigue. The scanning of the fibers may be done very rapidly since the magnification used is low enough to permit all focusing of the microscope to be done with the coarse adjustment. Even without taking particular precautions, the error in brush-knot composition determination may be held within reasonable limits of ± 2 per cent using either optical system.

Acknowledgment:

The authors are indebted to The American Brush Manufacturers Assn. for suggesting and supporting this investigation and for permission to submit this paper for publication.

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The Bookshelf

(*Continued from page 24*)

frequently only partly effective. The high mobility of hydrogen in steel is said to explain the unusual mechanical features of embrittlement and the conflicting results of many tests for the phenomena. Normal strength of high-strength steel is rarely affected, but ductility may be greatly reduced. The magnitude of hydrogen embrittlement was found to depend greatly upon numerous mechanical, chemical, and electrochemical factors encountered in the making, shaping, heat-treating, and finishing of aircraft parts. **PB 121700; 96 pp.; $2.50.**

Chemical Surface Treatment of Aluminum

Two chemical baths for coating the surfaces of titanium and its alloys for remarkable wear resistance are described: (1) heat-treated trisodium phosphate-fluoride or sodium-tetraborate-fluoride; (2) MoS_2—Epon-resin is added to the heat-treated phosphate-fluoride or borate-fluoride to coat the surface and provide resistance against high-speed rotary wear under relatively high loads. Sodium tetraborate fluoride bath 242D gave the most versatile coating to all alloys tested and caused only slight pH changes. Another advantage was control and reproducibility of the bath. Both treatments proved valuable because they produced wear resistance at a temperature below that of any phase transformation of titanium alloys. Phosphate-fluoride coatings showed promise in wire and tube-drawing evaluations, and similar promise was expected of borate-fluoride coatings. **PB 111805; 43 pp.; $1.25.**

Research and Development for the Welding of Titanium and Titanium Alloys

Successful welding of titanium alloys containing chromium, iron, manganese, aluminum, and molybdenum by the inert-gas shielded tungsten-arc welding process is described. Helium shielding gas was found more suitable than argon because it resulted in higher deposition rates, and thoriated tungsten electrodes were used in preference to unthoriated electrodes. Soundness of the welds was satisfactory. Welding within the chamber filled with inert gas resulted in an improvement in arc stability and a mirror-like surface of the weld metal but did not improve ductility. Bend tests showed ductility to be lacking but heat treatment improved it in some of the welds. Exceptional soundness was obtained with respect to the formation of blowholes or gas pockets in the weld metal, and the material was free of cracks. No evidence of fissuring was encountered. Tensile strengths of weld metal and joints were equivalent to the parent metal. Heat treatment did not seem to affect the size or large columnar structure of the as-deposited weld metal.
PB 111849; 79 pp.; $2.

On the Testing of Cement

The Cement Statistical and Technical Assn., Malmo, Sweden; 57 pp.; $1.40

THIS BOOKLET, second in the series "Cembureau Papers," summarizes the finding of a Working Party on Cement Standards appointed by Cembureau in 1949 to study the international cement specifications with the aim of promoting uniformity in test methods. It includes a method for testing the strength of cement, a joint proposal of the Working Party and RILEM.

FEDERAL GOVERNMENT STANDARDS

The General Services Administration of the Federal Supply Service is charged with the responsibility for establishing specifications to be used by the Federal Government for procurement of materials and supplies. The GSA issues an annual Index of Initiation of Federal Specifications Projects, and monthly supplements.

The items listed below appeared in Supplements Nos. 1 and 2 for the months of March and April 1957.

INITIATIONS

Title	Type of Action	Symbol or Number	FSSC Class	PSC Code	Assigned Agency & Preparing Activity
Adhesive, Animal Gelatin	Int. Am. 1	MMM-A-100	8040	52	GSA-FSS
Bone-Black; Dry (Paint-Pigment)	Rev. Rev.	TT-B-600a & TT-B-00600a (GSA-FSS)	8010	52	GSA-FSS
Cadmium-Yellow (Cadmium-Lithopone); Dry (Paint-Pigment)	Rev.	TT-C-83a & TT-C-0083a (GSA-FSS)	8010	52	GSA-FSS
Carbon-Black; Dry (Paint-Pigment)	Rev.	TT-C-120a & TT-C-00120a (GSA-FSS)	8010	52	GSA-FSS
Cupric Sulfate, Pentahydrate, Technical	Rev. Rev.	O-C-828 & O-C-00828a (DOD-CmlC)	6810 6810	.. ..	DOD-CmlC DOD-CmlC
Cushioning Material	Int. Am. 2	PPP-C-843	8135	..	GSA-FSS
Drums, Metal, Shipping, Over-12-gallon to 54-gallon	New New	PPP-D-705 & PPP-D-00705 (COM-BDSA)	8110	..	COM-BDSA
Drums, Metal, Shipping, 1-gallon thru 12-gallon	New	PPP-D-00704 (COM-BDSA)	8110	..	COM-BDSA
Hose, Coolant System, for Motor Vehicles	Rev.	ZZ-H-428	4720	23	DOD
Magnesium Alloy Plate and Sheet	Am. 3	QQ-M-44a	....	..	DOD-Navy-AER
Metallic-Brown; Dry (Paint-Pigment)	Rev. Rev.	TT-M-257a & TT-M-00251a (GSA-FSS)	8010	52	GSA-FSS
Paint, Exterior, Fire-Retard and (White and Light Tints)	New	TT-P-34 & TT-P-0034 (Army-CE)	8010	52	DOD-Army-CE
Plastic Compounds, Molding, Cellulose Acetate Butyrate; and Molded or Extruded Parts	Am. 1	L-P-349a	9330	..	DOD-SigC
Tape; Pressure-Sensitive Adhesive, Waterproof for Packaging and Sealing	Am. 2	PPP-T-60	8135	..	COM-BDSA

WITHDRAWALS

Title of Specification	Type of Action	Symbol or Number	Assigned Agency or Technical Committee	Reason for Withdrawal
Plastics, Polystyrene, Molded Parts and Extrusions	Rev.	L-P-416	DOD-ORD	DOD has no interest

PROMULGATIONS

Title	Type of Action	Symbol or Number
Aggregate: (For) Portland-Cement-Concrete	Am. 1	SS-A-281b
Aluminum-Alloy Forgings, Heat-Treated	Am. 1	QQ-A-367d
Anode, Nickel (Superseding Fed. Spec. QQ-N-265)	New	QQ-A-677
Cement, Slag	New	SS-C-218
Hydraulic Fluid, Non-Petroleum Base, Automotive-(Superseding Fed. Spec. VV-F-451a)	New	VV-H-910
Lubricants, Liquid Fuels, and Related Products;—Methods of Testing	(Correction to Fed. Std. 791 Change Notice 1)	
Paint, Latex Base, Interior, Flat White & Tints	Am. 1	TT-P-29
Piles; Wood (Superseding Fed. Spec. MM-P-371)	Rev.	MM-P-371a
Plastic Compounds, Molding and Extrusion, Polyethylene	New	L-P-590
Soap, Grit (Hand Cake) (Superseding Int. Fed. Spec. P-S-00576b(GSA-FSS) & Fed. Spec. P-S-576a)	Rev.	P-S-576c
Sodium Carbonate—Bicarbonate Mixture (Superseding-Int. Fed. Spec. P-S-00641c(GSA-FSS) & Fed. Spec. P-S-641b)	Rev.	P-S-641d
Sodium Polyphosphate, Technical, Water Treatment —Superseding Int. Fed. Spec. O-S-00635a (Navy-Docks)	New	O-S-635b
Steel Plates, Shapes and Bars, Carbon, Structural	Am. 1	QQ-S-741a

INTERIM FEDERAL SPECIFICATIONS ISSUED

Title	Type of Action	Symbol or Number
Adhesive, Animal Gelatin	Int. Am. 1	MMM-A-100(GSA-FSS)
Carbon-Black: Dry (Paint-Pigment)	Int. Rev.	TT-C-00251a(GSA-FSS)
Detergent (Synthetic) Built, High and Low Sudsing	Rev. 1	P-D-00245(GSA-FSS)
	Int. Rev.	TT-M-00251a(GSA-FSS)
Metallic-Brown; Dry (Paint-Pigment)	New	SS-P-00359(GSA-FSS)
Pipe, Clay (Perforated)	Rev. 1	P-S-00606b(GSA-FSS)
Soap Powder, Alkaline		

CANCELLATIONS

Title	Symbol or Number	Reason for Cancellation
Leather; Cattlehide, Mineral-Tanned (Hydraulic Packing)	KK-L-177b	Superseded by Fed. Spec. KK-L-163
Paste; Masking (For Use in Painting)	TT-P-181	Cancelled
Varnish; Spirit (Shellac Varnish-Replacement)	TT-V-130	Cancelled

SPECIFICATIONS AND STANDARDS APPROVED FOR PRINTING

Title of Specification	Type of Action	Symbol or Number
Anode, Nickel	New	QQ-A-677
Boxes; Fiber Corrugated (For Domestic Shipment)	Canc.	LLL-B-631c
Boxes Fiber	New	PPP-B-636
Boxes, Fiber, Solid, (For Domestic Shipment)	Canc.	LLL-B-636c
Calcium Hypochlorite and Chlorinated Lime, Technical	Rev.	O-C-114a
Cloth, Cotton, Drill	New	CCC-C-426
Cloth, Cotton, Duck, Unbleached, Plied-Yarns (Army & Numbered)	Am. 1	CCC-C-419
Cords, Cotton; General Purpose, Sash and Venetian-Blind	Rev.	T-C-571b
Cutting Oil, Base, Sulfurized-Lard Oil	Am. 1	C-C-800
Ethyl Alcohol (Ethanol), Denatured Alcohol Proprietary Solvent	Canc.	O-E-760b
Fluid, Hydraulic Brake	Rev.	VV-F-451a
Hydraulic Fluid, Non-Petroleum Base, Automotive	New	VV-H-910
Indian-Red and Bright-Red (Iron-Oxide);—Dry (Paint-Pigments)	Canc.	TT-I-511a
Lithopone; Dry (Paint-Pigment)	Canc.	TT-L-426
Lithopone; Dry (Paint-Pigment)	New	TT-P-40C
Lubricants, Liquid Fuels, and Related Products; Methods of Testing	Correction to Change Notice 1	Fed. Std. No. 791
Nickel; Anodes	Canc.	QQ-N-265
Oil; Soybean, Refined (For Use in Organic Coatings)	Canc.	TT-O-388
Pigment, Indian Red and Bright Red (Iron Oxide), Dry (For Use in Protective Coatings)	New	TT-P-375
Pipe Fittings, Cast Iron, Screwed 125 and 250 Pound	Am. 1	WW-P-501c
Plastic Compounds, Molding and Extrusion, Polyethylene	New	L-P-590
Remover, Paint (Alkali-Type)	Am. 1	TT-R-230
Soap, Grit (Hand Cake)	Rev.	P-S-576c
Sodium Carbonate—Bicarbonate Mixture	Rev.	P-S-641c
Sodium Polyphosphate, Technical, Water Treatment	New	O-S-635b

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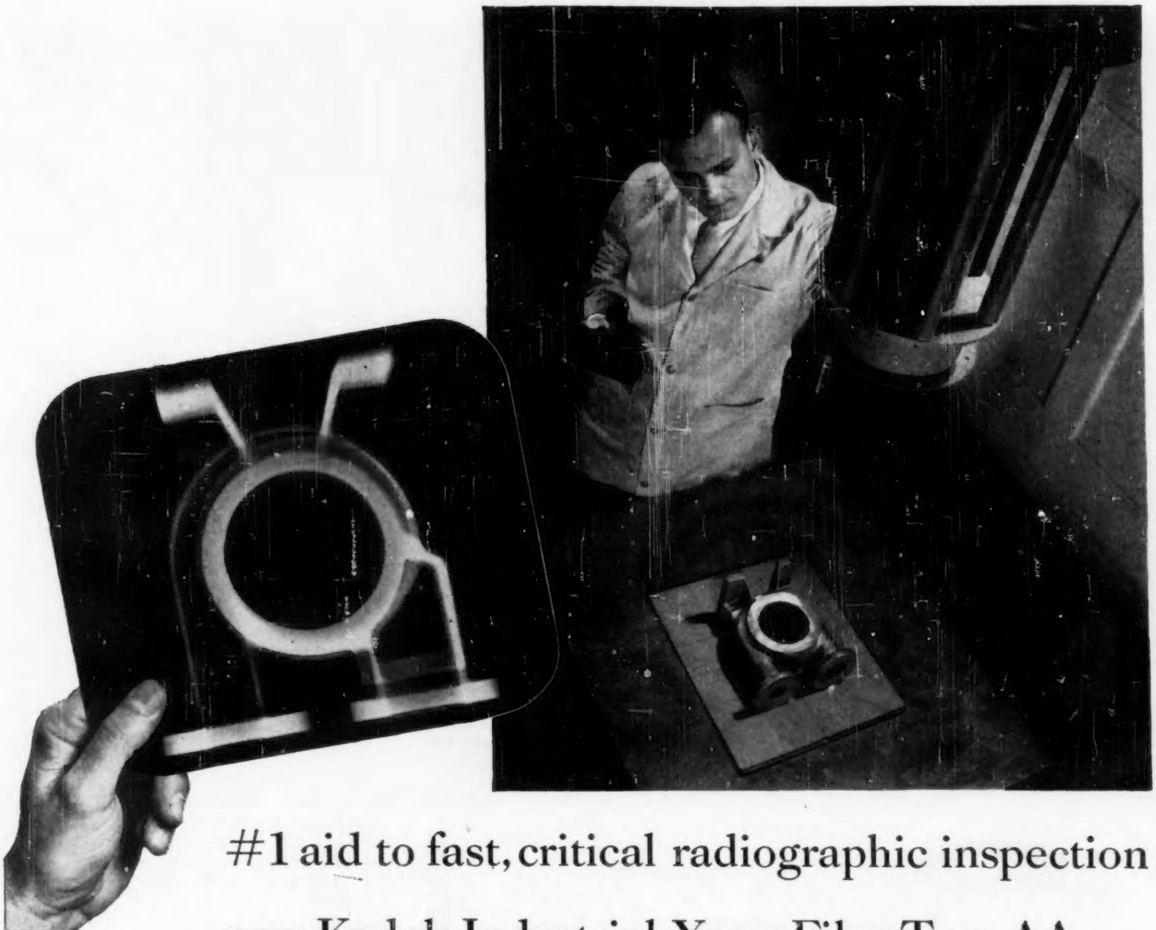

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- Reduces the possibility of pressure desensitization under the usual shop conditions of use.

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Kodak Industrial X-ray Film, Type AA and Type M is now available in 100-sheet boxes wrapped without interleaving paper. Designated as AA-100; M-100.

FOR FURTHER INFORMATION CIRCLE 610 ON READER SERVICE CARD PAGE 97

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column

Recently nominated officers of the Inter-Society Color Council all are active in ASTM: **Walter C. Granville,** color consultant, Chicago, Ill., is slated for president; **G. L. Erikson,** executive vice-president, Braden Sutphin Ink Co., for vice-president; **Ralph M. Evans,** Color Control Div., Eastman Kodak Co., for secretary; and **Norman Macbeth,** Macbeth Corp., for treasurer. **W. J. Kiernan,** of the Bell Telephone Laboratories, is nominated as a director.

F. A. Benger recently retired as chief of motive power and rolling stock, Canadian Pacific Railway Co., Montreal, after 46 years of service. He is succeeded by **L. B. George.**

Ruben N. Bergendoff, consulting engineer of Kansas City, Mo., was one of four engineers who received the Missouri Honor Award for Distinguished Service in Engineering from the University of Missouri. A member of the firm of Howard, Needles, Tammen & Bergendoff, he was cited for "outstanding achievements in the design of long- and short-span bridges, valuable contribution to development of modern highway turnpikes, expressways, and interchanges, and untiring service in advancement of the engineering profession and to civic enterprises."

I. E. Boberg, until recently chief engineer, has been elected a vice-president of the Chicago Bridge & Iron Co., Chicago, Ill.

Robert D. Bonney retired August 31 as vice-president—manufacturing, Congoleum-Nairn, Inc., Kearny, N. J. Affiliated with ASTM since 1919, Mr. Bonney has been very active in the work of the Society, both administrative and technical phases. He served two terms as a director (1939–1941; 1949–1952). He was a member of the Administrative Committee on Standards for a number of years, serving as chairman 1946–1950. He has served as a member of the Administrative Committee on End-Use Products since 1946. His most intensive technical activity has been concentrated in Committee D-1 on Paint, Varnish, Lacquer and Related Products where he has served on a number of the subcommittees, heading Subcommittee V on Volatile Solvents for Organic Protective Coatings for some time. He has been a member of Committee D-1 for the past 38 years. He also has served for many years on Committee D-6 on Paper and Paper Products, and represents this main group on Committee D-8 on Bituminous Waterproofing and Roofing Materials. Mr. Bonney resides in Elkton, Md. (Green Haven Farm, Route 1).

Llewellyn M. K. Boelter, chairman of the department of engineering, University of California, who received an honorary degree as doctor of engineering this year from Purdue University, will receive the Annual Medal of The American Society of Mechanical Engineers at the ASME meeting in December. He is cited for "outstanding contributions . . . as engineer and educator," with reference to his "revolutionary new ideas" in engineering education at both the graduate and undergraduate levels, and the fact that he led in preparation of the book *Heat Transfer,* a standard text.

Hyman Bornstein, retired manager, materials engineering department, Deere and Co., Moline, Ill., was named chairman of the recently formed research committee of the American Foundrymen's Society Training and Research Inst. He also is serving on the building and finance committees of the Institute.

Harry Elmo Bovay, Jr. of the H. E. Bovay, Jr. consulting engineering firm of Houston, Tex., recently announced the merger of his company and that of the Reg F. Taylor firm, the new company continuing under the name of H. E. Bovay.

W. W. Broughton, formerly with Newton New Haven Co., West Haven, Conn., is now plant manager, Stella Products Corp., Livingston, N. J.

C. R. Calkins has been named director of research and development for Riegel Paper Corp., Milford, N. J.

C. O. Christenson, until recently technical director, Acme Building Materials, Inc., Indianapolis, Ind., is now deputy special assistant for urban renewal, Federal Housing Administration, Washington, D. C.

R. Clark has been appointed manager, laboratories and research, Atlas Steels, Ltd., Welland, Ont., Canada.

William D. Clement, formerly instructor, department of mechanical engineering, University of New Hampshire, is now Major, U.S.A.F. Institute of Technology, Wright-Patterson AFB, Dayton, Ohio.

Herbert K. Cook is now vice-president for engineering, The Master Builders Co.,

(*Continued on page 62*)

Personals

(Continued from page 60)

division of American-Marietta Co., Cleveland, Ohio. This is one of three new posts recently created in line with the growth of Master Builders.

Irvin L. Cooter is new chief of the Magnetic Measurements section at the National Bureau of Standards, Washington, D. C. In ASTM he is active on Committee A-6 on Magnetic Properties.

W. H. Corddry, until recently vice-president, has been elected president of Gannett, Fleming, Corddry & Carpenter, Inc., Harrisburg, Pa.

Marcel A. Cordovi, head of the materials and testing department of Babcock & Wilcox Co., New York City, atomic energy division, received the second annual Industrial Achievement Award of the New York Chapter of the American Society for Metals for his "brilliant achievements in the field of metallurgy." In addition to his duties at Babcock & Wilcox, Mr. Cordovi is an adjunct professor of metallurgical engineering of the Polytechnic Institute of Brooklyn, a metallurgical consultant to Brookhaven National Laboratory and the official United States representative to the International Institute of Welding. In ASTM he is very active on Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, having served as secretary of this main group; also is a member of the Special Administrative Committee on Nuclear Problems.

Robert M. Crichton, formerly applications engineer, Minneapolis-Honeywell Regulator Co., Portland, Ore., is now City Enginer, Hood River, Ore.

Roy Dahlstrom has been appointed director of research, National Lead Co., New York City.

Clifford Anderson Duke, chief, electrical laboratory and test branch, Tennessee Valley Authority, Chattanooga, Tenn., has been transferred to the grade of Fellow in the American Institute of Electrical Engineers for his "contributions to the organization of a testing laboratory and staff for a large power system."

Martin C. Falk, formerly chief research engineer, The Yoder Co., has accepted a position as chief engineer with Steel Equipment Co., Cleveland, Ohio.

Harry L. Fisher, who recently retired as director of the TLARGI Rubber Technology Foundation, has been elected the first honorary member of the Washington Rubber Group, and also an honorary fellow of the Institution of the Rubber Industry, London.

J. H. Foote, president, Commonwealth Associates, Inc., Jackson, Mich., was a delegate to the meetings of the International Electrotechnical Commission held in Moscow in July.

Louis R. Forbrich has been appointed general manager of the Green Bag Cement Division of Pittsburgh Coke and Chemical Co., Pittsburgh, Pa. He joined the company in 1946 as chief chemist and assistant superintendent of the division and has been superintendent since 1950.

Thomas G. Foulkes has been appointed metallurgical engineer on the staff of S. J. Cort, operating vice-president of Bethlehem Steel Co., Bethlehem, Pa. A graduate of Miami University, with metallurgical degrees from the Colorado School of Mines, he has been with the company since 1923 in various capacities. Mr. Foulkes is being assigned to several of the ASTM metals committees.

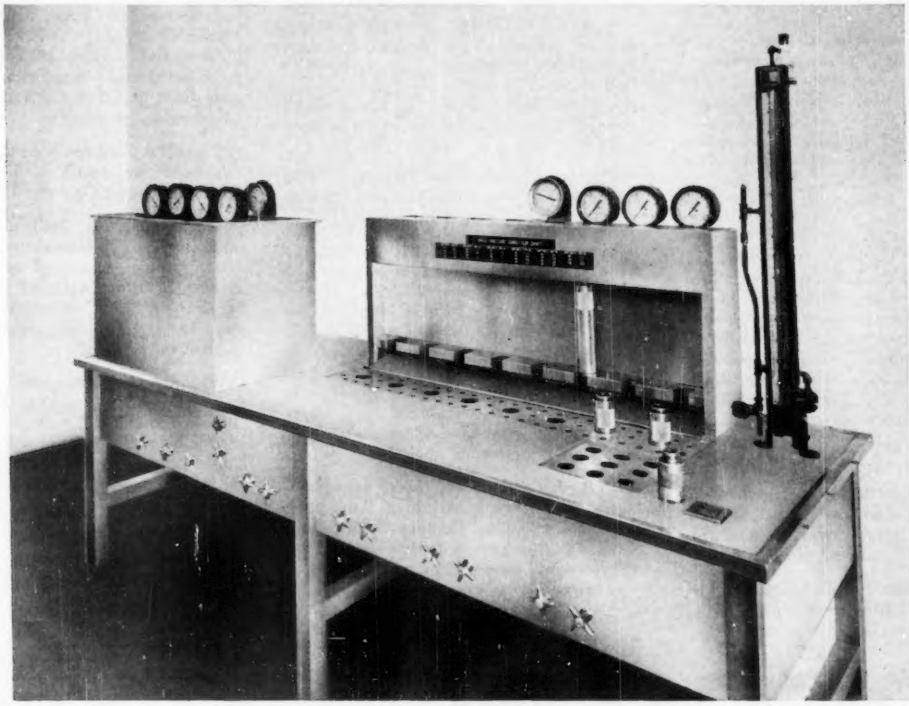
John Fox, until recently senior partner, John Fox and Partners, Sussex, is now associated with Belliss & Morcom, Ltd., London, England.

Richard J. Frazier, production manager for Anchor Concrete Products Co., Buffalo, N. Y., has been promoted to vice-president—director of production for the company. He also is in charge of Anchor's research, new production development, and quality control programs.

(Continued on page 64)

C.R.C. INTEGRATED REID VAPOR PRESSURE TEST UNIT

For Testing Vapor Pressure of Petroleum Products by The A.S.T.M. Method



ORIGIN

The C.R.C. Integrated Reid Vapor Pressure Test Unit was originally designed in the control laboratory of a leading Ohio oil refinery. It is more compact and efficient than previous equipment which required the technician to clean the bombs in several operations. Thus, the time requirement for test equipment preparation is nearly cut in half.

PURPOSE

The A.S.T.M. Method Test — A.S.T.M.-D-323-55 (Vapor Pressure of Petroleum Products, Reid Method) is the test used by most petroleum laboratories for routine control of motor and aviation gasoline volatility, and refinery gas plant operations. Integrated with the bomb preparation equipment is the test equipment required to conduct the A.S.T.M. procedures. The C.R.C. Integrated Reid Vapor Pressure Test Unit is designed to permit the accomplishment of eight tests simultaneously with very little more effort and time than was formerly required for a single test.

OPERATION

The C.R.C. Integrated Reid Vapor Pressure Test Unit saves a maximum of the technician's time. Normal time-consuming bomb preparation is minimized by the unit as after the parts of the bomb assembly have initially been placed on the unit, only the air chamber must be moved from the air purge rack to the wash rack, and the gasoline chamber from the disposal rack to the cooling bath. During the purging and washing operations the technician is free to utilize his time for other laboratory work.

FACILITIES

The C.R.C. Integrated Reid Vapor Pressure Test Unit is designed for use with standard A.S.T.M. bombs and gauges. Facilities provided on the unit include:

1. Air Purge System — provides air supply for drying gauges and expansion chambers.
2. Water Wash System — wash racks for water washing the expansion chambers, after air purging, at room temperature.
3. Constant Temperature Bath — brings the bomb assembly to maximum equilibrium pressure and is controlled by an electric immersion type heater regulated by a high sensitivity thermostat.
4. Drain Facilities — to dispose of wash water and samples.
5. Gauge Testing Facilities — mercury manometer in 0.1 pounds per inch of 0 to 20 pound range is provided for gauge checking.
6. Bomb Dismantling and Assembling Wrench — a socket wrench is mounted on the table top for easy dismantling of bomb assemblies.

ADVANTAGES

Eight tests may be accomplished as easily as one with a minimum of additional effort. Actual time required for each set of samples previously cooled is 45 minutes but actual work time for eight samples requires about 15 minutes of the tester's time. All controls are at fingertip reach of the tester and are placed at the front of the unit for convenient operation. Stainless steel finish on the unit, copper tubing and brass valves assure little or no maintenance.

SPECIFICATIONS

The entire unit is constructed of type 302 stainless steel with a #4 finish on all exposed surfaces. All piping is of copper tubing and valves are red brass with chrome plated remote control handles identified with color coded discs. The stainless steel table legs have rubber shoes and leveling screws on each leg to make installation on uneven floor surfaces simple. Installation requires 115 volt AC single phase electricity, approximately 100 psi compressed air, hot water, cold water and drain connections. The standard eight place unit is 98" long, 36" deep and 51" high. Special sizes could be supplied should your space requirements not meet the standard size.

For full descriptive information on the C.R.C. Integrated Reid Vapor Pressure Test Unit write today on company letterhead for Technical Bulletin 1-A-R.

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FOR FURTHER INFORMATION CIRCLE 614 ON READER SERVICE CARD PAGE 97

Personals

(*Continued from page 62*)

Alfred M. Freudenthal, professor of civil engineering, Columbia University, New York City, has been selected to receive the Norman Medal of the American Society of Civil Engineers for his paper on "Safety and the Probability of Structural Failure." The award will be made at the ASCE annual meeting in New York on October 16.

Milton A. Glaser, vice-president, Midland Industrial Finishes, Waukegan, Ill., and president of the Federation of Paint & Varnish Production Clubs, and **Louis Ludwig** of the paint research department of Sherwin-Williams Co., Chicago, were given Outstanding Service Awards by the Chicago Paint & Varnish Production Club. Mr. Glaser was mentioned as an ardent supporter of the club's educational program, and Mr. Ludwig as a stalwart leader of the technical program.

Abraham Goldstein, formerly chemical engineer, Naval Air Rocket Test Station, Dover, N. J., is now research engineer, Fluor Corp., Ltd., Covina, Calif.

Harry Gordon, until recently chief chemist, Bond Rubber Corp., Derby Conn., is now general manager, Ideal Rubber Products Co., Brooklyn, N. Y.

Walter C. Granville, formerly assistant director, department of design, Container Corporation of America, and coauthor of the Color Harmony Manual, has announced establishment of an independent practice as color consultant in Chicago, 1337 W. Fargo Ave.

William J. Harris has retired as chief metallurgist, laboratory division, Studebaker-Packard Corp., South Bend, Ind.

Ernest C. Hartmann, assistant director of research, Aluminum Company of America, New Kensington, Pa., is announced as recipient (with John Wood Clark, research engineer, and Harry N. Hill, assistant chief, engineering design division) of the ASCE Thomas Fitch Rowland Prize for a paper on "Design of Aluminum Alloy Beam-Columns." The award will be presented in October at the ASCE annual meeting.

L. F. Hickernell has been appointed vice-president—engineering of Anaconda Wire & Cable Co., Hastings-on-Hudson, N. Y. In his new post Mr. Hickernell will have full responsibility for directing the engineering, as well as the research and development activities of the company.

Loring K. Himelright recently was appointed head of the civil engineering department at the Citadel, Charleston, S. C. Major Himelright, who has been a member of the faculty since 1943, is also a soil mechanics and foundation engineering consultant for Soil Consultants, Inc. of Charleston.

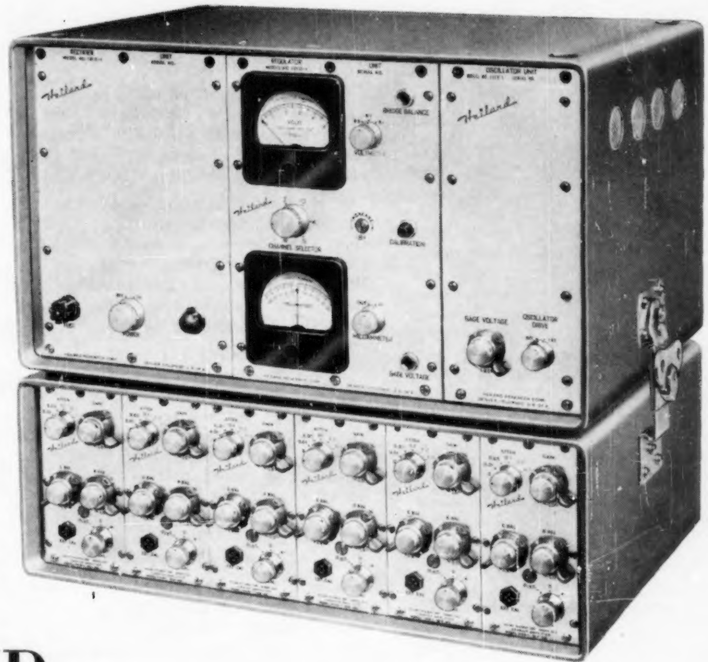
Everett S. Hoff has been made manager, Summerill Stainless Tube Div., Columbia Steel & Shafting Co., Pittsburgh, Pa.

Wesley J. Holtz, head, earth materials laboratory, U. S. Bureau of Reclamation, Denver, Colo., is named to receive, with Harold J. Gibbs, engineer in the laboratory, the ASCE Arthur M. Wellington Prize for paper on "Engineering Problems of Expansive Clays."

Whitney C. Huntington, head, department of civil engineering, University of Illinois, Urbana, Ill. was elected to honorary membership in the American Society of Civil Engineers, recognition to be made at the ASCE annual meeting in October.

Robert O. Jackob has been appointed supervisor of inspection and field service, Tatnall Measuring Systems Co., subsidiary of The Budd Co., Phoenixville, Pa.

(*Continued on page 66*)



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- **TEN TIMES THE CURRENT OUTPUT**
  50 ma into 20-ohm load
- **EXCELLENT STABILITY**
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All operating controls are on the front panel; all cabling is on the back panel for handy relay rack or test bench mounting without modification.

The 119 System is flexible to meet present or future needs, since all 6 individual amplifier units within the system are easily removable. You can build your system from the ground up, adding new individual units as your need expands.

In addition, linear-integrate and carrier units are interchangeable within the system case.

FOR ADDITIONAL DETAILS WRITE FOR BULLETIN 101-NN
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FOR FURTHER INFORMATION CIRCLE 616 ON READER SERVICE CARD PAGE 97

Personals

(*Continued from page 64*)

Ralph S. Jessup, a National Bureau of Standards authority in the field of heat standards, has been awarded the Department of Commerce Gold Medal for Exceptional Service, the Department's highest honor. The award recognized "perfection of combustion calorimetry and development of the benzoic acid standard and the extension of precise laboratory techniques to measurements in difficult fields of fluorine reactions and solutions." Mr. Jessup, who has been with the Bureau for more than 40 years, is a member of the Thermodynamics Section of the Heat and Power Division.

Deane B. Judd, internationally known colorimetric expert, has been named assistant chief of the Optics and Metrology Division at the National Bureau of Standards. The recipient of a number of awards, Dr. Judd has been with the Bureau since 1927.

John D. Keane, until recently with the Armour Research Foundation in charge of chemical engineering research, has been appointed to the position of director of research and executive secretary of the Steel Structures Painting Council, Pittsburgh, Pa.

Thomas M. Kelly, formerly director of research, is now vice-president for research, The Master Builders Co., Cleveland, Ohio.

James T. Kemp, for many years with American Brass Co., Waterbury, Conn., is now associated with The British-American Metals Co., Ltd., Plantation House, Road Lane, London, England.

A. H. Kidder, in charge of testing division, Philadelphia Electric Co., Philadelphia, Pa., has been re-elected vice-president of the Northeastern Region of the National Society of Professional Engineers. Mr. Kidder is vice-chairman of the ASTM Philadelphia District.

Paul E. Klopsteg has been appointed associate director for research, National Science Foundation, Washington, D. C. Dr. Klopsteg has been professor of applied science and director of research of the Northwestern Technological Institute, Evanston, Ill., and is professor emeritus at Northwestern. He is a former president of the Central Scientific Co. During World War II he served with the office of Scientific Research and Development.

Richard W. Lampertz, formerly with Carter Carburetor Div., ACF Industries, is now assistant technical superintendent, General Cable Corp., St. Louis, Mo.

John A. MacLeod is now manager, power and steam, Brown Co., Berlin, N. H.

Charles I. Mansur, Mississippi River Commission, Vicksburg, is announced as corecipient with John A. Focht, Jr., McClelland Engineers, Houston, Tex., of the ASCE Thomas A. Middlebrooks Award for their paper on "Pile-Loading Tests, Morganza Floodway Control Structure."

ASTM Past-President **L. J. Markwardt,** assistant director, U. S. Forest Products Laboratory, Madison, Wis., received a superior service award in May at ceremonies in Washington, D. C., honoring career employees of the U. S. Department of Agriculture. Mr. Markwardt was cited "for demonstrating unusual competence, versatility, vision, and capable leadership in executing wood products research programs of major benefit to our national welfare, and furthering international unity through interchange of technical knowledge." His major contributions have included publications on the strength of wood, plywood, fiberboards, and other wood-base materials. Active for many years in ASTM, he served as president of the Society in 1950 and has helped draw many national standards covering the testing and use of wood for structural purposes. Since 1948 Mr. Markwardt has served as chairman of Committee D-7 on Wood. He is also a past-secretary of this committee.

A. S. Marvin has been made chief engineer, American Bridge Div., U. S. Steel Corp., Pittsburgh, Pa.

William J. Morgan, formerly metallurgist, Alco Products, Inc., Latrobe, Pa., is now laboratory supervisor, Krouse Testing Machine, Inc., Columbus, Ohio.

(*Continued on page 68*)

Personals

(*Continued from page 66*)

Carl J. Oxford, Jr., has been advanced to the position of director of research for National Twist Drill and Tool Co., Rochester, Mich. Formerly research engineer, Mr. Oxford will now be in charge of all laboratory and research activities with special emphasis on the various aspects and problems connected with metal cutting.

Louis A. Patronsky, formerly director of research, Wabash Screen Door Co., Minneapolis, Minn., is now product development engineer, Pack River Tree Farm Products Co., Spokane, Wash.

M. Rea Paul has retired from Solvay Process Division, Allied Chemical and Dye Corp., New York City. Mr. Paul had represented his company in the Society and on a number of committees for many years. He had been very active in Committee D-1 on Paint, Varnish, Lacquer, and Related Products since 1930. He was a member of the organizing group and chairman of Committee E-12 on Appearance since its organization in 1948 until his recent retirement when the committee elected him honorary chairman, in recognition of valued contributions and loyal service. Mr. Paul now resides at 1214 N.W. 118th St., Miami, Fla.

Daniel D. Pollock, research metallurgist, has been named chief, alloys group, metallurgical section, Leeds & Northrup Co., Philadelphia, Pa.

Arthur E. Schuh, director of research and development, U. S. Pipe and Foundry Co., Burlington, N. J., received an Award of Scientific Merit from the American Foundrymen's Society "for conscientious effort in AFS cupola research investigations and in development of the society's basic ferric publications."

Leonard R. Sheppard is now research engineer, U. S. Gauge Div., American Machine and Metals, Sellersville, Pa.

J. Henri Siegel has been appointed to superintend the Technological Processes Division of the newly established Metallurgy Department at the U. S. Naval Engineering Experiment Station, Annapolis, Md. Mr. Siegel has been at the Station for 23 years. In ASTM he is active in Committee E-7 on Nondestructive Testing.

C. Norman Sjogren, formerly with C. F. Braun and Co., Alhambra, Calif., is now president, Chemet Engineers, Inc., Pasadena, Calif.

Albert P. Spooner has retired as chief metallurgical engineer, Steel Div., Bethlehem Steel Co., Inc., Bethlehem, Pa. He began his career with Bethlehem Steel in 1915. A longtime member of the Society, affiliated since 1920, Mr. Spooner has served through the years on a number of the metals committees, his most intensive activity being in Committee A-1 on Steel where he has made valued contributions as a member of the Advisory Committee and several of the subcommittees. He has been instrumental in developing a number of the test methods and specifications in the castings and forgings fields. Mr. Spooner is a past president of the Lehigh Valley Chapter, American Society for Metals, and has served on various committees for the United States Navy. He is a former member of the Ferrous Metallurgical Advisory Board of the U. S. Army.

Irwin J. Steinhardt, until recently with General Electric Co., Buffalo Tube Plant, is now senior engineer, Sylvania Microwave Lab., Mountain View, Calif.

Alexander Stewart has been elected president and general manager, R-N Corp., New York City, owned equally by National Lead Co. and Republic Steel Corp.

William C. Stewart has been appointed to head a recently established metallurgy department of the U. S. Naval Engineering Experiment Station, Annapolis, Md. The new department, uniting the work of the Station's former metallurgical and welding laboratories, is comprised of a technological processes division and a metals division; and is the first of four major specialized departments being established in the reorganization of the Station's technical laboratories, designed to meet the Navy's accelerated research and development program. Mr. Stewart is very active in a number of the ASTM metals committees.

O. H. Storey, for many years associated with the Gypsum Assn., Chicago, Ill., has assumed the position of gypsum products manager with Flintkote Co., Inc. Presently he is organizing a new gypsum products Flintkote division in Dallas, Tex.; however, his permanent company address will be at the main office, 30 Rockefeller Plaza, New York City. Mr. Storey has been serving as secretary of ASTM Committee C-11 on Gypsum since 1954.

Leif J. Sverdrup, consulting engineer, St. Louis, Mo., and a major general in the U. S. Army Reserve, received a certificate of achievement presented by Army Secretary Wilbur Brucker in Pentagon ceremonies, citing his "exemplary contributions to the development and military readiness of the reserve components of the Army."

W. Kedzie Teller, formerly secretary and chief chemist, The Columbus Laboratories, Chicago, is now executive vice-president, Pharma-Craft Co., Batavia, Ill.

George E. Warren, president of the **Southwestern Portland Cement Co.,** which recently commemorated its golden anniversary with an interesting brochure providing data on the history of cement and its uses, has been affiliated with ASTM since 1920. He was a director 1929–1931. Southwestern Portland has been a Company member since 1926 and a Sustaining Member for many years. Mr. Warren

(*Continued on page 71*)

Personals

(Continued from page 68)

currently is chairman of the board of the Portland Cement Assn. A long-active member of ASTM Committee C-1 on Cement, he was elected to honorary membership in the committee in 1954.

J. Stephen Watkins, consulting engineer of Lexington, Ky., has announced the opening of a new branch at 407 Hale Street, Charleston W. Va., under the direction of Maurice R. Hamill.

Albert G. Welch, formerly research associate, Engineering Experiment Station, University of New Hampshire, Durham, is now associate research professor, Engineering and Industrial Experiment Station, University of Florida, Gainesville, Fla.

Edward A. Weymouth has been appointed manager of sales for the Michigan Limestone Div., Detroit, Mich., of U. S. Steel Corp., Cleveland, Ohio.

Harold F. Wiley, formerly technical services department director, has been named director of the new Analytical and Control Instruments Div., Consolidated Electrodynamics Corp., Pasadena, Calif.

Joseph Winlock recently retired as chief metallurgist, The Budd Co., Philadelphia. He had represented his company for many years in the Society and on certain of the metals committees. Mr. Winlock is succeeded by **Ralph Leiter**.

T. Van Dyke Woodford, until recently with Walter N. Handy Co., Evanston, Ill., is now on the engineering staff of Chicago Fly Ash Co., Green Bay, Wis.

John S. Worth, for many years assistant metallurgical engineer, has been appointed metallurgical engineer on the staff of S. J. Cort, operating vice-president of Bethlehem Steel Co., Bethlehem, Pa. A graduate of Lehigh University, Mr. Worth has been with Bethlehem Steel since 1933. He has had charge of a group of products including castings, drop and upsetter forgings, and industrial fasteners. Affiliated with ASTM since 1941, he has been very active in Committee A-1 on Steel, and its Subcommittees XXII on Valves, Fittings, Pipings and Flanges for High-Temperature and Subatmospheric Temperatures and XXVI on Bolting. He also has been a member of the joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals for the past 16 years, serving on a number of the panels.

Frank L. Wright has been appointed director of engineering and research, Coolidge Corp., Middletown, Ohio. He was formerly works manager with Norma-Hoffmann Bearings Corp., Stamford, Conn., and more recently manufacturing manager and consultant, Pneumafil Corp., Charlotte, N. C.

B. C. Yearley, director of applied research, National Malleable and Steel Castings Co., Cleveland, Ohio, was named chairman of the recently formed building committee of the American Foundrymen's Society Training and Research Institute.

NEW MEMBERS . . . .

The following 145 members were elected from June 18 to August 14, 1957 making the total membership 9001 . . . . . Welcome to ASTM

Note—Names are arranged alphabetically—company members first then individuals—Your ASTM Year Book shows the areas covered by the respective Districts

CHICAGO DISTRICT (5)

Henry Engineering Co., Inc., Raymond Henry, president, 5300 River Dr., Moline, Ill.

Backstrom, Norman, Test Group—Plastics Lab., Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave. S., Minneapolis 8, Minn.

Harris, Robert A., material engineer, Western Electric Co., Inc., Hawthorne Station, Chicago 23, Ill.

Illinois, University of, Textiles and Clothing Div., Mrs. Ruth Galbraith, associate professor, Urbana, Ill.

Kaar, Thomas R., building commissioner, Village of Oak Lawn, 9429 S. Cook Ave., Oak Lawn, Ill.

Kantor, Max, technical director, Vegetable Oil Div., Cargill, Inc., 200 Grain Exchange Bldg., Minneapolis 15, Minn.

Macpherson, Robert B., chief engineer, The Anderson Co., 1075 Grant St., Gary 40, Ind.

Spicer, A. D., manager, plant engineering, American-Standard, Kewanee Boiler Div., Kewanee, Ill.

Thacker, Richard L., owner, Thacker Engineering Office, 226 Washington St., Waukegan, Ill.

Trumbull, John, president, Emulsified Asphalts, Inc., 4900 S. Mason Ave., Chicago 38, Ill.

Zerbe, John I., research assistant professor, Small Homes Council, University of Illinois, 31 E. Armory, Champaign, Ill. For mail: 1809 Carle Dr., Urbana, Ill.

CLEVELAND DISTRICT (4)

General Electric Co., Lamp Leads and Bases Dept., Lamp Div., Mrs. Ruth Knutsen, librarian, 17825 St. Clair Ave., Cleveland 10, Ohio.

Rozsa, John T., vice-president and technical director, National Spectrographic Labs., Inc., 6300 Euclid Ave., Cleveland 3, Ohio.

DETROIT DISTRICT (6)

Eaton Manufacturing Co., Powdered Metals Div., Charles R. Wright, project engineer, 325 Jay St., Coldwater, Mich.

Compton, J. W., supervisor, industrial application research, Wyandotte Chemicals Corp., Wyandotte, Mich.

Daniels, Roger L., chief engineer, Formsprag Co., 23601 Hoover Rd., Warren, Mich.

Fenn, Raymond W., Jr., Metallurgical Lab., 241 Bldg., The Dow Chemical Co., Midland, Mich.

Fox, Kenneth James, engineer, Frankel Co., 19300 Filer, Detroit Mich. For mail: 13651 Balfour, Oak Park 37, Mich.

Frazier, Kenneth S., chief research engineer, Fenestra, Inc., 2250 E. Grand Blvd., Detroit 11, Mich.

Kearfott, A. J., assistant department head, General Motors Corp., Research Staff, Box 188, North End Station, Detroit 2, Mich. For mail: 16034 Curwood, Highland Park 3, Mich.

Martin, David Edwin, research engineer, General Motors Corp., Special Problems Dept., Research Staff, Box 188, North End Station, Detroit 2, Mich. [A]*

Satchell, Fred E., chief chemist, Brunswick-Balke-Collender Co., 1700 Messler St., Muskegon 82, Mich.

Turk, John G., director, packaging research lab., Glass Container Manufacturing Inst., 99 Park Ave., New York 16, N. Y. For mail: 121 S. South St., Lansing 10, Mich.

NEW ENGLAND DISTRICT (13)

Friis, Bjorn S. T., metallurgist, National Pneumatic Co., Holtzer-Cabot Divs., 125 Amory St., Boston, Roxbury 19, Mass.

Gaines, John A., plant metallurgist, John W. Bolton and Sons, Inc., 9 Osgood St., Lawrence, Mass. For mail: "Candlewick," East Derry, N. H.

Karcher, R. W., manager, engineering lab., General Electric Co., 1200 Western Ave., West Lynn 3, Mass.

Martin, Ralph, staff metallurgist, Electric Boat Div., General Dynamics Corp., Eastern Point Rd., Groton, Conn.

Savits, J. B., chief methods engineer, Pneumatic Scale Corp., Ltd., Newport Ave., North Quincy 71, Mass.

NEW YORK DISTRICT (1)

American Abrasive Metals Co., J. I. Forsyth, secretary, 460 Coit St., Irvington, N. J.

Atlantic Wire Co., The, E. S. Tyler, products control manager, 1 Church St., Branford, Conn.

Cities Service Research and Development Co., Bernard H. Rosen, manager, product development, Cranbury, N. J.

General Electric Co., Engineering Lab., Medium AC Motor and Generator Dept., R. M. Brissey, manager of laboratory, Bldg. 50-3, 1 River Rd., Schenectady 5, N. Y.

Voland and Sons, Inc., Bernard Wasko, chief engineer, 32 Relyea Pl., New Rochelle, N. Y.

Will Laboratories, Inc., A. Williams, 14-27 Broadway, Long Island City 6, N. Y.

Booth, Richard W., supervising engineer, engineering lab., County of Essex, N. J., Hall of Records, Newark 4, N. J. For mail: 69 Overlook Terrace, Nutley 10, N. J.

Borup, Richard E., head, analytical div., Cities Service Research and Development Co., Cranbury, N. J. For mail: Box 402, Cranbury, N. J.

Carley, James F., engineering editor, *Modern Plastics*, Breskin Publications, 575 Madison Ave., New York 22, N. Y.

Coutris, Achilles W., engineer, Moran, Proctor, Meuser & Rutledge, 415 Madison Ave., New York, N. Y. For mail: 419 W. 119th St., Apt. 6A, New York 27, N. Y. [A]

Diehl, Donald A., director, research and development center, The Fyr-Fyter Co., Box 750, Newark 1, N. J.

Endicott, Harold S., dielectric measurements engineer, General Electric Co., General Engineering Lab., Schenectady 5, N. Y.

Herwig, Gannett, partner, LaPierre, Litchfield and Partners, 292 Madison Ave., New York 17, N. Y.

Leckie, William, sales engineer, Triplex Oil Refining Co., Inc., 37-80 Review Ave., Long Island City, N. Y.

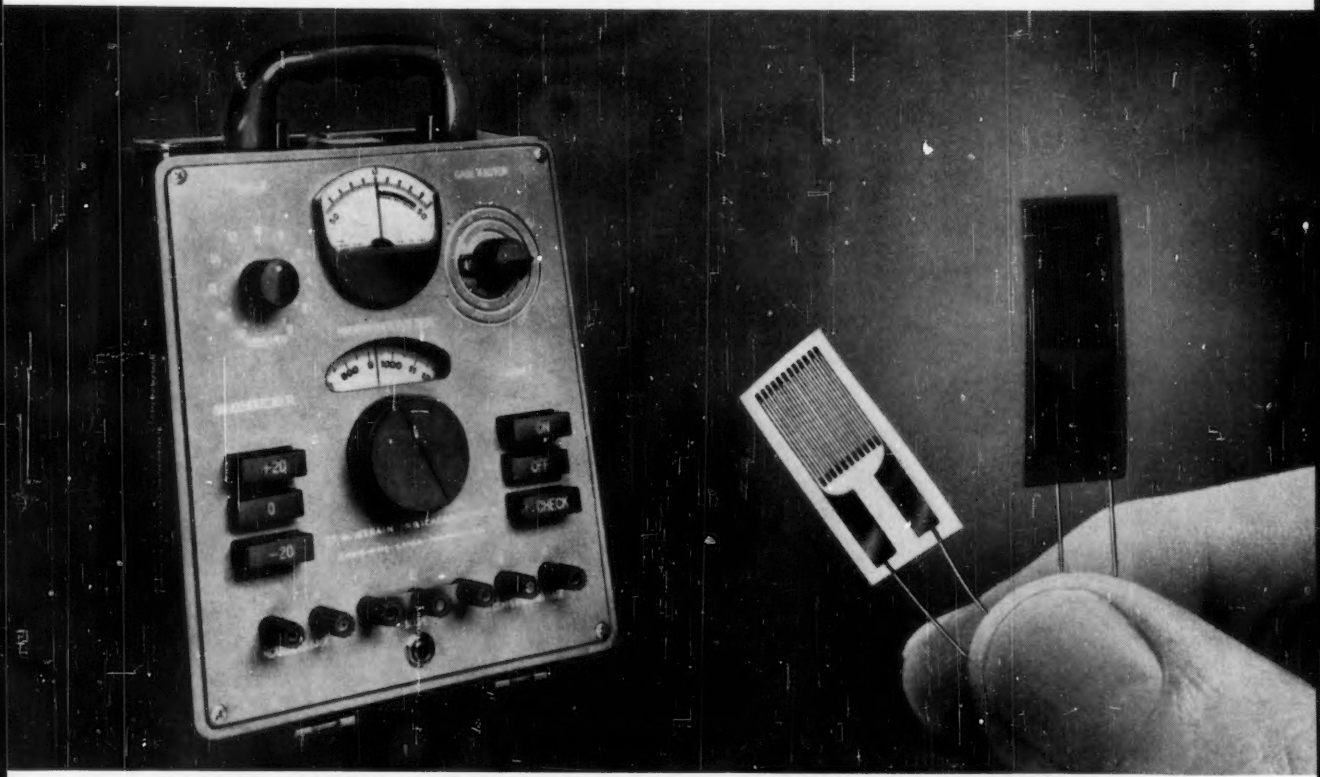
Marsilio, Bruno, secretary-treasurer, Independence Plating Corp., 107 Alabama Ave., Paterson 3, N. J.

Maslow, Philip, supervisor, coatings lab., Ciba Co., Inc., Plastics Div., Kimberton, Pa. For mail: 739 E. 49th St., Brooklyn 3, N. Y.

(*Continued on page 76*)

* A denotes Associate member.

Newest strain-measuring equipment from Baldwin



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Two new types of foil gage in ½ in. gage length, 120 ohms resistance, now make many types of stress analysis possible with new accuracy and ease. A Bakelite-bonded gage, Type FAB-2, and a quick-drying paper-and-cement-bonded gage, Type FAP-2, have marked advantages over comparable standard bonded wire strain gages. Hysteresis is now so low as to be negligible for stress analysis. Fatigue life of the paper gage matches that of comparable wire gages—that of the Bakelite gage is longer. Lateral strain sensitivity of both is down by one-half, offering new accuracy in measuring biaxial strains. The quick-drying paper gage is quick and easy to install. The Bakelite gage offers such attractive features as dependable service at 300°F or higher. It is thinner and more flexible than comparable bonded wire gages—requires no preforming for curved surfaces and is thus easier to apply. Its glass fiber filler makes it less sensitive to moisture effects.

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FOR FURTHER INFORMATION CIRCLE 628 ON READER SERVICE CARD PAGE 97

New Members

(*Continued from page 72*)

Mruk, Stanley A., chemical engineer, Allied Chemical and Dye Corp., Box 309, Columbia Rd., Morristown, N. J.
Press, J. J., 302 96th St., Brooklyn 9, N. Y.
Reese, Warren B., vice-president, Macbeth Corp., Box 950, Newburgh, N. Y.
Rothstein, Samuel, consulting engineer, Fairchild Camera and Instrument Corp., Robbins Lane, Syosset, L. I., N. Y. For mail: 79-19 269th St., New Hyde Park, N. Y.
Steele, William S., president, American Vermiculite Corp., 527 Madison Ave., New York 22, N. Y.
Sterling, William Thomas, soils engineer, E. Lionel Pavlo, 642 Fifth Ave., New York, N. Y. For mail: 268 S. Van Dien Ave., Ridgewood, N. J. [A]
van Venrooy, John, specialist in fibers, Rayonier, Inc., S. Jefferson and Cedar Knolls Rds., Whippany, N. J.

NORTHERN CALIFORNIA DISTRICT (8)

Heldman, C. W., engineer, Soulé Steel Co., 1750 Army St., San Francisco, Calif. For mail: 2470 West Ave. 134th, San Leandro, Calif.
Layton, R. E., consulting engineer, 655 West Ave. 135th, San Leandro, Calif.
O'Neil, Hugh M., structural engineer, Hugh M. O'Neil Co., Engineers, 610 16th St., Room 402, Oakland 12, Calif.
Smith, William R., specialist, materials and welding, Atomic Power Equipment Dept., General Electric Co., 2151 S. 1st St., San Jose 25, Calif. For mail: 2772 Lansford Ave., San Jose 25, Calif.
Vivino, David D., textile consultant, U. S. Army Procurement Agency Korea, APO 301, San Francisco, Calif. [A]

OHIO VALLEY DISTRICT (15)

Eyermann, Louis M., consultant, 3602 Lexington Rd., Louisville 7, Ky.

PHILADELPHIA DISTRICT (2)

Carco Industries, Inc., Charles A. Russo, president, 7341 Tulip St., Philadelphia 35, Pa.
General Electric Co., Switchgear and Control Div., William L. Healy, specialist, Laboratories Dept., 6901 Elmwood Ave., Philadelphia 42, Pa.
Magnet Cove Barium Corp., Harry M. Gwyn, Jr., district manager, Box 6504, Houston, Tex. For mail: 702 Western Saving Fund Bldg., Philadelphia 7, Pa.
Bianchetta, Peter F., engineer, Summit Mining Corp., Aspers, Pa.
Courtney, Neville C., consulting engineer, Justin & Courtney, 121 S. Broad St., Philadelphia 7, Pa.
Hartman, James B., professor and head, Department of Mechanical Engineering, Lehigh University, Bethlehem, Pa.
Marks, William H., specifications head, Dixie Cup Co., Easton, Pa.
Pennington, Fred A., partner, Andrew S. McCreath and Son, 236 Liberty St., Harrisburg, Pa.
Robinette, Hillary, Jr., president, Robinette Research Laboratories, Inc., 16 E. Lancaster Ave., Ardmore, Pa.
Swift, Robert B., Jr., sales manager, Henry Vogt Machine Co., 1338 Commercial Trust Bldg., Philadelphia 2, Pa.
Webster, Earle F., flat belt development engineer, Quaker Rubber Co., Tacony and Comly Sts., Philadelphia, Pa. For mail: Barberry Court Apts. D-31, Moorestown, N. J.

PITTSBURGH DISTRICT (3)

Cross, Alan, Pittsburgh Consolidation Coal Co., Research and Development Div., Process Design, Library Pa. For mail: 350 Travis Dr., Pittsburgh 36, Pa. [A]
Drumwright, Thomas F., research engineer, Alcoa Research Labs., Box 772, New Kensington, Pa. [A]
Miller, John H., vice-president, engineering, Thomas Machine Manufacturing Co., Pittsburgh 23, Pa.
Murphy, Edward L., service metallurgist, United States Steel Corp., 525 William Penn Way, Pittsburgh 30, Pa. For mail: 44 Marlin Dr. W., Pittsburgh 16, Pa.
Stalnaker, Robert A., supervisor, physical testing lab., Robertshaw-Fulton Controls Co., Robertshaw Thermostat Div., Youngwood, Pa.
Tisdale, Norman F., Jr., partner, Canam Metallurgical Sales Co., 2401 Grant Bldg., Pittsburgh 19, Pa. [A]
Wallace, James P., resident inspection supervisor, Pittsburgh Testing Laboratory, Box 1646, Pittsburgh 30, Pa. For mail: Box 441, Newburgh, Ind.

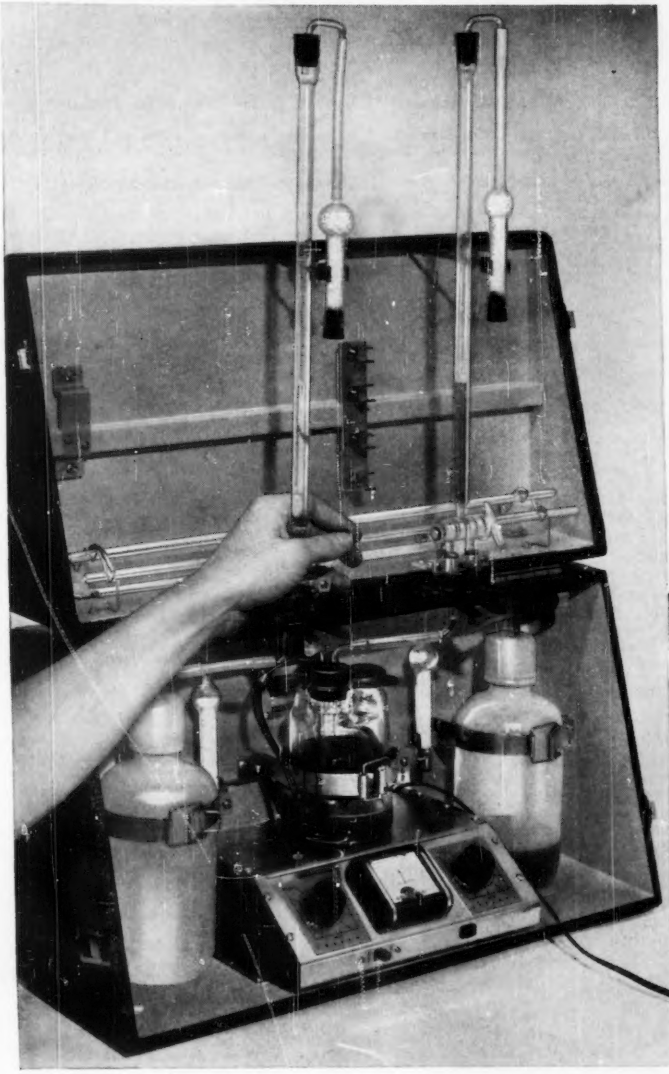
ST. LOUIS DISTRICT (9)

San Ore Construction Co., Inc., M. Clare Miller, president, Box 417, McPherson, Kans.
Helling, Fred S., chemist, Penn-Central Oil Co., 2727 S. Roe, Kansas City, Kans. [A]

SOUTHEAST DISTRICT (17)

Sangamo Electric Co., Pickens Div., Howard E. Lee, electrical engineer, Box 666, Pickens, S. C.
Blackwell, Homer D., architect, Lyles, Bissett, Carlisle & Wolff, 1321 Bull St., Columbia, S. C. For mail: P.O. Drawer 110, Columbia, S. C.
Caler, B. A., works engineer, Westinghouse Corp., Box 1461, Athens, Ga. For mail: 205 Gran Ellen Dr., Athens, Ga.

(*Continued on page 78*)



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Refinery Supply Company—Tulsa • Houston
Central Scientific Co. of Canada, Ltd.—Toronto • Montreal • Vancouver • Ottawa

FOR FURTHER INFORMATION CIRCLE 633 ON READER SERVICE CARD PAGE 97

New Members

(*Continued from page 76*)

Johnson, Hugh B., technical advisor, International Paper Co., Container Div., Georgetown, S. C. [A]

Joyner, Charles L., engineer, U. S. Navy Mine Defense Lab., Panama City, Fla. For mail: 1608 W. 10th St., Panama City, Fla.

Kent, Harry R., estimator and purchasing agent, Canady Construction Co., Box 932, Charleston, S. C.

Peacock, Robert E., control engineer, Holloway Concrete Products Co., Winter Park, Fla. For mail: Box 507, Maitland, Fla.

SOUTHERN CALIFORNIA DISTRICT (7)

Clay Pipe Institute, Joseph A. Donovan, secretary-manager, 315 W. 9th St., Rm. 704, Los Angeles 15, Calif.

Thermo Materials, Inc., James L. Hall, vice-president in charge of manufacturing, 4040 Campbell Ave., Menlo Park, Calif.

Escondido, City of, Engineering Dept., 100 Valley Blvd., Escondido, Calif.

Hawke, James P., chief engineer, J. H. Pomeroy and Co., Inc., 3625 W. 6th St., Los Angeles 5, Calif.

Rhodes, Mason M., refinery chief chemist, Standard Oil Co. of California, Western Operations, Inc., Box 97, El Segundo, Calif.

SOUTHWEST DISTRICT (16)

Standard Television Tube Corp., W. T. Freeland, president, 706 Dryades St., New Orleans 12, La.

Barnes, Marvin J., quality control manager, Black, Sivalls & Bryson, Inc., 2131 Westwood Blvd., Oklahoma City, Okla.

Elliott, Robert L., Hard Chrome Plating Co., Chemical Lab., 1502 W. 34th St., Houston 18, Tex. [A]

Gere, John L., chief engineer, Cities Service Gas Co., Box 1995, Oklahoma City 1, Okla.

Greaux, Austin E., assistant professor of architectural engineering, Prairie View Agricultural and Mechanical College, Prairie View, Tex. For mail: Box 2521, Prairie View, Tex.

Misegades, Edgar L., manager, engineering lab., General Electric Co., Troup Hwy., Tyler, Tex.

WASHINGTON, D. C., DISTRICT (14)

Price Electric Co., Division of Consolidated Electronics Industries Corp., Paul N. Martin, chief engineer, E. Church St., Frederick, Md.

Jones, William M., executive director, National Building Granite Quarries Assn., 1028 Connecticut Ave. N. W., Washington, 6, D. C.

Mitchem, E. P., president, Atlantic Building Co., Inc., Box 3345, Charlotte, N. C.

Young, J. Stanley, housing consultant, 1228 Connecticut Ave. N. W., Washington 6, D. C.

WESTERN NEW YORK-ONTARIO DISTRICT (10)

Antoniades, Michael Th., development chemist, Roxalin Company of Canada, Ltd., New Toronto, Ont., Canada. For mail: 266 Lakeshore Rd., Apt. 86, Toronto, Ont., Canada.

Pennachetti, John T., president, Thorold Concrete Block Co., Thorold, Ont., Canada.

U. S. AND POSSESSIONS

Utah Water and Power Board, Ray H. Zenger, engineer, 425 State Capital Bldg., Salt Lake City 14, Utah.

Bennett, James Edward, Jr., chief, materials control branch, F. C. Torkelson Co., Engineers, Box 185, Idaho Falls, Idaho. For mail: 100 E. 16th St., Idaho Falls, Idaho.

Clevenger, William A., vice-president, Woodward-Clyde and Associates, 1240 W. Bayaud St., Denver 23, Colo.

Eberline, Rex L., assistant city engineer, Box 1293, Albuquerque, N. Mex.

Fairhall, William M., manager, engineering dept., Reynolds Electrical and Engineering Co., 931 S. Main St., Las Vegas, Nev. For mail: 1212 Cherokee Lane, Las Vegas, Nev.

Groth, Willis G., senior welding engineer, ACF Industries, Inc., 336 Woodward Rd., Albuquerque, N. Mex. For mail: 524 Bryn Mawr Dr., S. E., Albuquerque, N. Mex.

Kavanagh, John R., materials engineer, Castle Concrete Co., Colorado Springs, Colo.

Ryan, Alfred J., consulting engineer, 1340 Glenarm Pl., Denver 4, Colo.

Swanson, Walfred E., vice-president and general manager, Roberts Construction Co., 1018 Trust Bldg., Lincoln 8, Nebr.

Thornley, William H., Jr., laboratory head, Woodward-Clyde and Associates, 1240 Bayaud St., Denver 23, Colo.

U. S. Air Force Academy Library—AFL 7000, Archie Higdon, professor of mechanics, Denver 8, Colo.

Wanner Donald E., staff member (materials lab.), Sandia Corp., Sandia Base, Albuquerque, N. Mex. For mail: 1025 Dakota St. S. E., Albuquerque, N. Mex.

OTHER THAN U. S. POSSESSIONS

Ampol Petroleum, Ltd., R. L. Ashley, assistant lubricants manager—Australia, Box 5342, GPO Sydney, N. S. W. Australia.

Canadian Steel Foundries (1956), **Ltd.,** G. L. McMillin, vice-president and general manager, 5227 Notre Dame St., E., Montreal, P. Q. Canada.

Carbide Chemicals Co., George L. Bata, associate director—development—resins, Box 1199, Montreal 3, P. Q., Canada.

Instituto de Chimica Industriale del Politecnico de Milano, Piazza Leonardo da Vinci 32, Milan, Italy.

Refinaria de Petroleos de Manguinhos S/A, Eduardo D. Difini, engineer, Avenida Brasil 3285, Rio de Janeiro, Brazil.

Spinners and Weavers Association of Korea, Kang Il Mai, president, 58-1, 2Ka Chong Ro, Chong Ro Ku, Seoul, Korea.

Sumitomo Metal Industries, Ltd., Hisakazu president, 31, Kawaramachi 4-chome, Higashi-ku, Osaka, Japan.

Ames, W., inspector-in-charge, General Motors-Holden's Ltd., Woodville, South Australia.

Boyd, R. N., supervising engineer, design services, Engineering Dept., du Pont Company of Canada (1956), Ltd., Box 660, Montreal, P. Q., Canada.

Cheng Kung University, chief librarian, Tainan, Taiwan, British Colony.

Cheron, M., directeur des recherches, Cimenteries and Briqueteries Reunies, S. A., Boulevard de Waterloo, 34, Brussels, Belgium.

Goodman, Keith S., manager, Materials Testing Laboratories, Ltd., 27—6A St. N. E., Calgary, Alta., Canada.

Gruenspan, Herzel, Box 1361, Haifa, Israel.

Guest, S. B., general manager, Ratcliffs (Canada) Ltd., Richmond Hill, Ont., Canada.

Haq, Qureshi Surah-Ul, technical assistant, Soil Mechanics and Hydraulics Lab., Ahmad Colony, Drigh Rd., Karachi 8, Pakistan. For mail: Top Floor, Karim Manzil, Young Husband Rd., Kharadar, Karachi, Pakistan. [A]

Kaper, C. N., manager, Fasting-Jonk N. V., Kneuterdijk 2a, Box 88, The Hague, The Netherlands.

Kersthold, Maximilian, construction superintendent, Pacific Architects and Engineers APO 500, San Francisco, Calif. For mail: Box 15, USNAS Navy 3835, FPO, San Francisco, Calif.

Koga, Yuzo, Toa Nenryo, Research Lab., Shimizu City, Shizuoka Pref., Japan.

(*Continued on page 82*)

New Members

(*Continued from page 78*)

Kuang-Feng, Lin, assistant engineer, Chia Nan Hydraulic Assn., 21 Hai-Tong St., Tainan, Taiwan, British Colony. For mail: Bureau of Reclamation, Training and Visitors' Section, % Val Killin, Room, 52, Bldg. 53, Denver Federal Center, Denver, Colo. [A]

Leoni, Sergio, naval mechanical engineer, Industrie Italiane del Petrolio, Casella Polstale 131, Mantova, Italy. For mail: Via Scuderie Reali 4, Mantova, Italy.

Long, H. W., general manager, Commonwealth Extrusion Corp., Box 914, Bayamon, Puerto Rico.

Luther, Charles C., quality control unit supervisor, Creole Petroleum Corp., New York, N. Y. For mail: % Creole Petroleum Corp., Cabimas, Estado Zulia, Venezuela. [A]

Mohsen, Ezz El Din, laboratory chemist, National Petroleum Co. of Egypt, 155 Mohamed Bey Faird, Cairo, Egypt. [A]

Möller, K. W. Torsten, director, Chalmers Prouningsanstalt, Teatergatan 5, Gothenburg C., Sweden.

Pakistan Standards Inst., Muhammadi House, McLeod Rd., Karachi 2, Pakistan.

Qureshi, Abdul Naeem, technical assistant, Soil Mechanics and Hydraulics Lab., Ahmad Colony, Drigh Rd., Karachi 8, Pakistan. For mail: 297/3 Martin Rd., Karachi 5, Pakistan. [A]

Rada, A., Victor Manuel, civil engeniero, Colegio de Ingeniros de Venezuela, Los Caobos, Caracas, Venezuela. For mail: Los Chagaramos, Calle Vargas, Qta. Mucuruba, Caracas, Venezuela.

Rapaport, Emek, textile engineer, Israel Standard Inst., 200 Dizengof St., Tel-Aviv, Israel. For mail: 7 Yehoash St., Tel-Aviv, Israel.

Rimmer, Arthur, head, physical test lab., Ashdowns Ltd., Eccleston Works, St. Helens, Lancashire, England. For mail: 7 Sycamore Rd., Huyton, near Liverpool, England.

Spohn, Eberhard, vorstandsmitglied, Portland-Zementwerke Heidelberg A. G., Riedstrasse 4, Heidelberg, Germany.

Tjokronolo, Sd., chief, Government Central Purchasing Office, Tanah Abang Barat 8, Box 49, Djakarta, Indonesia. For mail: Djalan Sungai Sambas III/12, Kebajoran, Djakarta, Indonesia.

Young, Peter L., Jr., materials engineer, U. S. Dept. of the Army, TransEast District, Corps of Engineers, APO 616, Karachi, Pakistan.

DEATHS . . .

Leon D. Cook, Jr., district sales engineer, Bart Manufacturing Corp., Detroit, Mich. (June 30, 1956). Member since 1947.

Beverly A. Evans, supervising engineer, du Pont Company of Canada, Ltd., Montreal, Canada. Member since 1955.

L. C. Flickinger, chief chemist, The Youngstown Sheet and Tube Co., Youngstown, Ohio (July 17, 1957). Member since 1948. Mr. Flickinger was a member of a number of the ASTM technical committees, representing his company on several prior to his personal membership, these including D-3 on Gaseous Fuels, D-16 on Industrial Aromatic Hydrocarbons and Related Materials, D-19 on Industrial Water, D-22 on Methods of Atmospheric Sampling and Analysis, E-2 on Emission Spectroscopy, and E-3 on Chemical Analysis of Metals.

Noah A. Kahn, principal metallurgist, New York Naval Shipyard, Brooklyn, N. Y.; residence, 3732 Oceanic Avenue, Brooklyn (June 20, 1957). A 1922 graduate of Lehigh University in chemical engineering, Mr. Kahn received his master of science degree from Washington University in 1927, assuming the position at the New York Naval Shipyard in 1927. In 1944 he received the Meritorious Civilian Award for distinguished service to the Navy. A pioneer worker in the development and application of radium radiography, Mr. Kahn directed the work at the Naval Shipyard Material Laboratory which led to issuance of the original Navy Department radiographic standards for steel castings for steam pressure service, and to development of the Bureau of Ships Universal Radium Exposure Calculator widely used by Government and industrial activities for computing exposure times in industrial gamma ray radiography.

In ASTM, Mr. Kahn had been a valued contributor to the work of Committee E-7 on Nondestructive Testing since 1938, heading Subcommittee II on Reference Radiographs, and serving on the Executive Council. He was a key factor in the Society's publishing of the reference radiographic standards for metal products under the jurisdiction of Committee E-7.

F. M. Kepler, manager, Henry Vogt Machine Co., Philadelphia, Pa. (December 21, 1956). Member since 1948.

H. R. Moulton, American Optical Co., Southbridge, Mass. Represented company on Committee C-14 and its Subcommittee III on Chemical Properties since 1938; also served on Committee D-20 on Plastics from 1938 to 1946.

John Charles Riedel, consulting engineer, and retired chief engineer of New York City's Board of Estimate, died in his home in Brooklyn on July 1. President of the New York State Society of Professional Engineers between 1935–1937, Mr. Riedel devoted 51 years of service to New York City, rising to chief design engineer with the Brooklyn Bureau of Sewers in the early 1900's before he began a long association with the Board of Estimate in 1934. He was a long-time member of the City Planning Commission and at 76 became chairman of the City Traffic Commission. Affiliated with a number of technical and professional organizations, Mr. Riedel had been a member of ASTM since 1921, serving on a number of committees in the ceramic field. His intensive technical activity in the Society was concentrated in Committee C-4 on Clay Pipe. He contributed to the work of this main group since 1937, serving as its chairman for the past 12 years.

J. E. Settle, president, Settle Engineers, Inc., Charleston, W. Va. Member since 1953.

Ben John Small, partner, in charge of specifications, LaPierre, Litchfield and Partners, 292 Madison Ave., New York, N.Y. (April 13, 1957). Member since 1956.

G. D. Smith, sales agent, G. D. Smith Co., 600 16th St., Oakland, Calif. Member since 1952, serving on Committee E-7 on Nondestructive Testing and its Subcommittee VI on Ultrasonic Testing.

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The compact Fisher/Tag Saybolt Viscosimeter is an interchangeable two and four tube instrument for making both Saybolt Furol and Saybolt Universal viscosity measurements of oils. Readings are made easily, quickly and precisely at automatically - controlled temperatures ranging from 60°F to 220°F.

for direct viscosity measurements of light and **heavy** oils

according to ASTM D88

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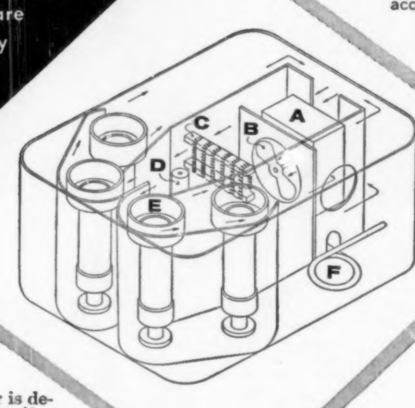

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C—Heater
D—Regulator
E—Saybolt Tubes
F—Cooling Unit

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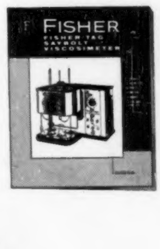

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B-23

FOR FURTHER INFORMATION CIRCLE 640 ON READER SERVICE CARD PAGE 97

NEWS NOTES ON

Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The society is not responsible for statements advanced in this publication.

LABORATORY ITEMS

DC Bridge—The BC-1 is a companion component for any amplifier. It provides an input circuit for conveniently connecting one, two, or four active wire strain arms into Wheatstone Bridge form.
Allegany Instrument Co. 1405

Tension and Compression Tester—Model 625 High Rate Tension and Compression Tester provides a completely calibrated stress-strain record of the deformation of a specimen, at rates as high as 6000 in. per min.
Allegany Instrument Co. 1406

Recording System—A new portable 300 KC Bandwidth Recordata System is being manufactured. A feature of this multichannel magnetic tape recording system is the selection, either remotely or from the front panel, of six speeds with appropriate equalization built-in to automatically compensate for each speed.
American Electronics, Inc. 1407

Indentation Tester—The McBurney Indentation Tester, an instrument to perform indentation tests on asphalt tile, and which meets Federal Specification SS-T-306b is available.
American Instrument Co., Inc. 1408

Random Pilling Tester—A new Random Tumble Pilling Tester has been announced. It is claimed that this instrument produces pills and fuzz which correlate well with actual end-use performance in respect to number, size, and appearance.
Atlas Electric Devices Co. 1409

Strain Gages—A foil type SR-4 (bonded filament) strain gage is now available in two types that provide fatigue life, sensitivity, and hysteresis characteristics.
Baldwin-Lima-Hamilton Corp. 1410

Stoppers—A unique rubber stopper for use in the laboratory and in glass blowing will fit as many as 17 different size openings, ranging from 22 to 100 mm. The Pluro Stopper is essentially a Size No. 15, 4 in. stopper sliced into 17 concentric tapered rings.
Bethlehem Apparatus Co., Inc. 1411

Tygon Tubing—Samples of colored Tygon tubing for hand torcher, lathe burners, bench burners in laboratories and glass shops will be sent upon request.
Bethlehem Apparatus Co., Inc. 1412

Radiography Machine—A compact radiography machine weighs 40 lb and has the penetrating power of a 400,000 volt X-ray machine. Called "Iriditron 40" it employs radioactive Iridium 192 in strengths up to 30 curies for nondestructive inspection of metals and other materials.
The Budd Co. 1413

Gas Chromatography—A highly sensitive detector cell for gas chromatography has been developed. Now standard equipment on all current models of the Burrell Kromo-Tag for analyses of gases and liquids in vapor-phase, they are also available as replacement parts.
Burrell Corp. 1414

Pressure Standard—New portable Primary Pressure Standard is a precise pneumatic dead-weight tester engineered to achieve new accuracies for the con-

(*Continued on page 86*)

40% lighter*... a man can carry it in one hand

30% smaller... he can pass it through a 12" hole

powerful enough to go through 2" thick steel, 5" aluminum

*Weighs only 73 pounds . . . *without sacrificing protective lead-shielding (offbeam radiation level is only 7 mr per hour at 6 feet)*

You can get immediate delivery on a new ANDREX 160 KV lightweight portable unit.
Call any Picker branch office (see local 'phone book) or write
Picker X-Ray Corporation, 25 South Broadway, White Plains, N. Y.

PICKER... one stop for everything in industrial fluoroscopy and radiography

- **ANDREX** lightweight portable x-ray units—130 KV, 160 KV, 200 KV, 260 KV and *Androscope* X-ray Stress Analyzer.
- **PICKER** x-ray units—5 to 50 KV, 150 KV (stationary and mobile), 270 KV portable, 260 KV heavy-duty, x-ray diffraction apparatus, rayproof inspection cabinets.
  ACCESSORIES . . . films, tanks, darkroom sundries, illuminators, *everything*.
- **TECHNICAL OPERATIONS** units for isotope radiography—sources, equipment, containers for Iridium 192 Cobalt 60 and Thulium 170.

Picker x-ray

FOR FURTHER INFORMATION CIRCLE 642 ON READER SERVICE CARD PAGE 97

Lab Items

(Continued from page 84)

venient calibration of pressure-measuring instruments.
Consolidated Electrodynamics Corp 1415

Tape Recorder—A new 14-channel Magnetic tape recorder/reproducer system, designed to handle analog, PDM and FM signals, has been announced.
Consolidated Electrodynamics Corp. 1416

Vacuum Trap—A new laboratory ultra-high-vacuum component, called TFG-51, for isolating a vacuum system from contaminating oil vapor and impurities is available.
Consolidated Electrodynamics Corp. 1417

Tear Tester—The Visual Tear Tester allows technicians to observe under a microscope the tearing and drawing properties of paper, yarn, etc.
Custom Scientific Instruments, Inc. 1418

Power Supply—A new 125-volt d-c power supply provides higher efficiency by the use of germanium rectifiers. This unit converts AC to DC for testing and servicing industrial d-c equipment.
Electro Products Labs. 1419

Potentiometers—A new concept in multiturn precision potentiometer construction has been announced. The type 909 model, a 7/8 in. diameter multiturn is the first in a series.
Fairchild Controls Corp. 1420

Reflectometer—Useful in matching a load to a transmission line or measurement of the reflection coefficient over a frequency range of 10 mc to 2400 mc.
Federal Instruments c/o International Telephone & Telegraph Corp. 1421

Portable Concrete Tester—Model FT-25 can apply controlled loads up to 8850 psi on standard 6 by 12 in. concrete cylinders.
Forney's Inc. 1422

Wet Film Thickness Gage—Meets the requirements of ASTM method of measurement of Wet Film Thickness of Paint, Varnish, Lacquer, and Related Products D 1212-54.
Gardner Laboratory, Inc. 1423

Silvered-Mica, Standard Capacitors—Type 1409 Standard Capacitors are available in 10 stock values from 0.001 to 1.0 microfarad.
General Radio Co. 1424

High Voltage Source—This unit provides a completely adjustable source of high potential (0-15 kv) for insulation, dielectric, and cable test information.
Harvey-Wells Electronics, Inc. 1425

Package Tester—A new 1000-lb conbur tester with a ballasted barrier absorbs a large portion of impact shocks yet does not interfere with testing efficiency.
L. A. B. Corp. 1426

Ultrasonic Testing—A completely portable, battery-operated ultrasonic thickness measuring unit locates areas of corrosion or wear on structures and products accessible from one side only.
Magnaflux Corp. 1427

Vacuum Melting Furnace—A research laboratory type furnace for vacuum melting of titanium, zirconium, vanadium, columbium, tantalum, and other metals that require controlled atmosphere melting is available.
Oregon Metallurgical Corp. 1428

Vapor Phase Chromatograph—Claimed to be capable of analyzing gaseous and liquid mixtures for components boiling up to 125 C (maximum operating temperature is 100 C). It is applicable to the analysis of hydrocarbons from methane through nonane and other components having similar boiling point range.
Podbielniak, Inc. 1429

Liquid Density Measurement—A precision-built instrument, which provides direct indication of liquid density of a continuously flowing process liquid, and which has a zero-set adjustment for original calibration under working conditions as well as temperature adjustment that permits setting to existing fluid temperatures to provide a temperature-corrected specific-gravity reading, has recently been developed.
Precision Thermometer & Instrument Co. 1430

Optical Creep Measurements—The development of testing equipment for use with vacuum furnaces arranged for optical creep measurements has been announced.
Riehle Testing Machines 1431

Fluid-Temperature Indicator—Rapid fluid-temperature measurements can be made at closely differentiated points. The instrument combines an indicating meter with a stainless-steel probe 12 in. long attached to a 30 in. length of flexible armored cable.
Royco Instruments 1432

Lambda-Pettes—A new line of six types of Lambda-Pettes for paper chromatography work has recently been made available. These new microliter pipets conform to ACS proposed specifications and tolerances for micropipets.
Schaar & Co. 1433

State-of-Cure Tester—Modifications applicable to equip T-50 State-of-Cure Tester for temperature retraction and brittleness tests, are announced.
Scott Testers, Inc. 1434

Power Supply Unit—A new, compact, power supply unit that is filtered and regulated by transistors and designed primarily for use as a power supply for a 120 ohm strain gage bridge has recently been developed.
Spar Engineering & Development, Inc. 1435

Portable Compression Tester—A new compact, portable, hydraulically operated machine for quick accurate compression testing has been announced. This unit combines simple hand pump operation with ease of adjustment in vertical dimension, and a capacity of 150,000 lb.
Steel City Testing Machines, Inc. 1436

Electronic Gage—A new type of electronic gage called the Versachek has been announced. It converts minute differences in established dimensions into voltage changes and amplifies them for reading on a meter scale.
Taft-Peirce Mfg. Co. 1437

Temperature Test Chamber—A new temperature test chamber, the Tenney Series Ten, having a 10-cu-ft work space has been announced.
Tenney Engineering, Inc. 1438

(Continued on page 89)

Lab Items

(*Continued from page 86*)

Self-Balancing Indicator—A new, self-balancing indicator with built-in key or push-button switches is being offered. It is available for thermocouples with a null balance potentiometer measuring circuit and automatic cold-junction compensation; or for resistance bulbs with a null balance AC bridge measuring circuit.
Thermo Electric Co., Inc. 1439

Chromatography Cabinet—New corrosion-resistant chromatography cabinet for preparing two-dimensional paper chromatograms by descending or ascending techniques has been announced. The cabinet and vapor-tight, hinged cover are of 1-in. plywood bonded to white Formica inside and out.
Arthur H. Thomas Co. 1440

Rubber Laboratory Mill—A small mill for grinding experimental or test batches of rubber and plastics has been developed.
Todd Shipyards Corp., Los Angeles Div. 1441

CATALOGS and LITERATURE

Tape Recorder—Recording of instrumentation data is described in new booklet, Magnetic Tape Instrumentation.
Ampex Corp. 2277

Hi-Pot Testing—A comprehensive 10-page article on high potential testing is available free of charge.
Associated Research, Inc. 2278

Flame Spectroscopy—Unique 28-page, *Reprint R-100*, bibliography on Analytical Flame Spectroscopy by R. Mavrodineanu contains over 900 references arranged chronologically and alphabetically by author. These cover the evolution of analytical flame spectroscopy from 1848 up to date. Conveniently indexed are the various fields of applications in which this procedure is used.
Beckman Instruments, Inc., Scientific Instruments Div. 2279

Data Precision System—An eight-page brochure describes Model 112 Data Precision System, a practical data system for the process industries.
Beckman Instruments, Inc., Systems Div. 2280

High-Force Centrifuge—Details of the new Spinco Model K, a 51,000-time-gravity laboratory centrifuge, are given in a new publication identified as Form SBK-1.
Beckman Instruments, Inc., Spinco Div. 2281

Environment Testing—An illustrated two-color brochure, *Bulletin No. 5690*, on new testonic environmental cabinets features a combination of patented Power O-Matic Control System and constant-flow mechanical refrigeration to give accurate temperatures throughout entire temperature range, from 0 C to 180 C.
Blue M Electric Co. 2282

Ultrasonic Gaging—Two new ultrasonic testing bulletins, *Bulletin Nos. V-301* and *V-302*, are now available. These application data sheets discuss the uses of the Vidigage, an ultrasonic resonance instrument, for quick and accurate detec-

(*Please turn page*)

tion of corrosion and laminar flaws, and the measuring of metal or plastic thicknesses.
Branson Instruments, Inc. 2283

Pulse Calibrator—Designed for accurately measuring current and voltage pulse amplitudes, pulse durations and rise time, is now fully described in a technical brochure.
Burroughs Corp. 2284

Shock Tester—A two-color brochure, *Bulletin 4-70*, on the Hyge Shock Tester is available. It points out that this instrument provides for accurate simulation of shock experienced by equipment in actual use.
Consolidated Electrodynamics Corp., Rochester Div. 2285

Electromanometer—*Bulletin 1586* describes high-speed electromanometer with pressure reading in 0.1 sec. resolution 0.001 per cent of full scale.
Consolidated Electrodynamics Corp. 2286

Metals—*Bulletin 13* shows price list for standard samples of metals, alloys, and ores.
Crippen & Erlich Laboratories, Inc. 2287

Lab. Equipment—An eight-page bulletin *Bulletin No. G3-B60*, showing the latest improved models in equipment for rubber covering service, laboratory testing service, laboratory equipment, and engineering and mill design service is available.
Denver Equipment Co. 2288

Labware—New polyethylene laboratoryware catalog describes, illustrates, and prices a complete assortment of laboratory ware.
The Harshaw Chemical Co. 2289

Crystal Lattice Models—Crystal lattice models of chemical elements, compounds, minerals, and alloys are listed and illustrated in a 6-page descriptive bulletin.
Arthur S. LaPine & Co. 2290

Light for Color Matching—**"Color Sells—Yes,"** is the title of a 4-page bulletin, *Bulletin 262*, discussing in detail the uses to which daylighting has been put where the critical viewing or matching of colors to standards is a problem.
Macbeth Daylighting Corp. 2291

Industrial X-Ray—A series of portable, industrial X-ray equipment for radiographic inspection of castings, welds, assemblies, facilitates improvements and repairs on metal products, is illustrated and described in a 2 color, 4-page folder.
Mitchell Radiation Products Corp. 2292

Measuring—The A-B-C's of Accuracy in Weighing and Force Measurement Systems, a twelve-page primer-type brochure which explains proving rings and their use has been published.
Morehouse Machine Co. 2293

Sonic Gas Analyzer—A gas analyzer employing the velocity of sound and offering exceptional range, sensitivity, and rapidity of analysis, has been released.
National Instrument Laboratories, Inc. 2294

Dial Indicators—New bulletin, *Bulletin No. 557*, describes accuracy, $\frac{1}{5}$ of a graduation over the entire range. A 0.0001 in. indicator, for example, is accurate to within 0.00002 in. (twenty millionths).
Petz-Emery, Inc. 2295

X-Ray Inspection—A new bulletin, reprint of an article from American Aviation, gives details on methods used for automatic X-ray inspection of subminiature electron tubes.
Philips Electronics, Inc. 2296

Fluoroscopy—A new 6-page folder describes modern techniques for applying electronic fluoroscopy in metal examinations.
Philips Electronics, Inc. 2297

Catalog—A new 16-page edition of "What's New for the Laboratory," the 29th in the series has been announced.
Scientific Glass Apparatus Co., Inc. 2298

Oven Bulletin—Specialized ovens, water baths, and humidity chambers are illustrated and described in a new bulletin, *Bulletin 6-57*. These units are designed to be used in the field or laboratory for testing soils, concrete, asphalt, and other construction materials in accordance with ASTM and AASHO specifications.
Soiltest, Inc. 2299

Phasemaster—A new bulletin on the recently developed Model PM-1B Phasemaster is now available. The bulletin describes in detail the specifications and

applications of the phasemeter as well as significant features; it also contains illustrations and a diagram of the new unit.
Statham Development Corp. 2300

Balance Weights—A 6-page illustrated Lab Guide to Balance Weights includes new NBS laboratory weight classifications with tolerance for each plus a selection of balance weights by class.
Will Corp., Lab. Supply & Service Center 2301

Lab. Catalog—A number of new and interesting developments in laboratory equipment are presented in the latest 16-page issue of "Lab Log." Among them are the electrobalance, a photomicrography illuminator and AC line-operated spectrophotometer.
Will Corp. 2302

INSTRUMENT COMPANY NEWS

Allegany Instrument Co., Inc., Cumberland, Md.—New construction atop Wills Mountain in Cumberland, Md., will result in a 30 per cent increase in floor area. Alinco spokemen say that the new addition is necessary to accommodate increased materials and machinery for new instrumentation in the rocket and jet engine fields.

Automatic Timing & Controls, Inc., King of Prussia, Pa.—Transfer of operations by ATC to their new three-quarter million dollar plant in King of Prussia, Pa., has been completed. The 74,000 sq ft structure will double the capacity of the former Philadelphia concern, engaged in the manufacture of components for industrial automation. ATC also announced its change of name from the Automatic Temperature Control Co. to Automatic Timing & Controls, Inc.

Beckman Instruments, Inc., Fullerton, Calif.—Announced it has leased an additional 12 acres of land in Stanford Industrial Park, Palo Alto (Calif.), to expand the plant of its Spinco Div., manufacturer of specialized instrumentation for medical research.

Consolidated Electrodynamics Corp., Pasadena, Calif.—Established an Analytical and Control Instrument Div. announced by Hugh F. Colvin, president. Harold F. Wiley, director of the company's Technical Service Dept. the past four years, was appointed director of the new division, which will consolidate company activities in the design, development, and manufacture of analytical and control electronic instruments. Also, A. P. Stuhrman has been appointed manager of the Central Mfg. Div.

Consolidated Electrodynamics Corp., Pasadena, Calif.—The Spectron Div. has doubled its production capacity by purchasing the optical production and testing equipment of Testa Mfg. Co.

Frazier Precision Instrument Co., Silver Spring, Md.—The business for the manufacture of textile testing and research instruments of the late Sherman W. Frazier is being continued by the new management under the name of Frazier Precision Instrument Co., R. E. Ward and Wm. Grote, Proprietors, 8913 Glenville Road, Silver Spring, Md. William Grote and R. E. Ward of the new management announced that all of the instruments and services formerly furnished by the late Sherman W. Frazier will be manufactured and provided. Special consideration will be given to meet the urgent requests for instruments that have accumulated since the death of Mr. Frazier.

Test Lab., Chicago, Ill.—Test Lab., a new corporation engaged in the manufacture and marketing of apparatus and equipment for the laboratory and field engineering testing of soils, bituminous, and concrete materials, has gone into production.

this is a
dead load hardness tester with I.R.H.D.

- Calibrated in International Rubber Hardness Degrees. (The Standard for vulcanized, natural and synthetic rubbers.)
- This unique tester at last provides a truly accurate and reproducible standard for expressing rubber hardness.
- Dead weight loads — eliminating variables of springs and leverage.
- Vibrating buzzer in base.
- Large, clear dial reads direct in I. R. H. D.
- Conforms to ASTM D1415-56T
- Makes foot or base plate type tests.

Ask for complete technical data on this and our other Rubber and Plastic Testing Instruments.

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with hollow spindle

1/10 H.P. — Sparkless — Continuous Duty

This heavy-duty model of Eberbach's popular Hollow Spindle LAB-STIR is especially designed for continuous duty stirring of large volumes aqueous or other light viscosity solutions. Hollow spindle produces almost silent drive, gives positive grip yet offers rapid interchange of stirring rods. Rod length can be quickly adjusted up or down. Glass as well as steel rods can be used. Special design eliminates most "whipping" or "wobble". 115 V, 60 Cy.

For full details on LAB-STIR and accessories write for Bulletin 530F.

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CIRCLE 653 ON READER SERVICE CARD PAGE 97

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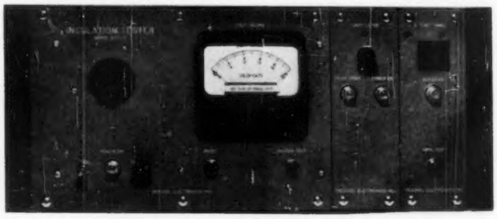

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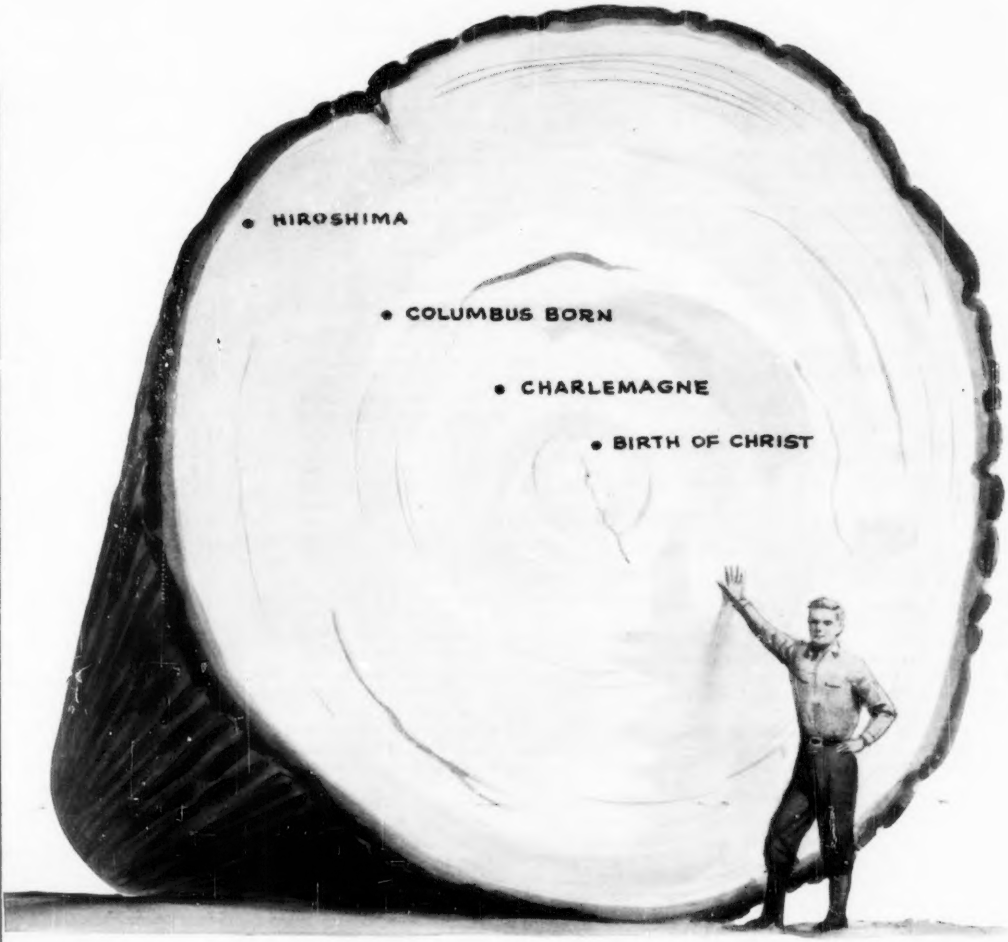

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OTHER SOCIETIES' EVENTS

September 30–October 2—**American Oil Chemists' Society,** Fall Meeting, Netherland Plaza Hotel, Cincinnati, Ohio.

October 6–9—**National Institute of Governmental Purchasing,** 12th Annual Conference and Products Exhibit, Netherland Hilton Hotel, Cincinnati, Ohio.

October 6–9—**Society of Petroleum Engineers of AIME,** Fall Meeting, Adolphus Baker and Statler Hilton Hotels, Dallas, Texas.

October 6–12—**Electrochemical Society,** Semiannual meeting, Statler Hotel, Buffalo, N. Y.

October 7–9—**National Electronics Conference (IRE, AIEE, RETMA, and SMPTE),** Hotel Sherman, Chicago, Ill.

October 7–9—**American Gas Assn.,** Annual Convention, Kiel Auditorium, St. Louis, Mo.

October 7–11—**Society of Photographic Scientists and Engineers,** National Conference, Berkeley-Carteret Hotel, Asbury Park, N. J.

October 7–11—**American Institute of Electrical Engineers,** Fall General Meeting, Morrison Hotel, Chicago, Ill.

October 9–11—**Society for Experimental Stress Analysis,** Annual Meeting, Hotel El Cortez, San Diego, Calif.

October 9–20—**World Isotope Conference,** Paris, France.

October 14–16—**Association of Official Agricultural Chemists,** Annual Meeting, Shoreham Hotel, Washington, D. C.

October 14–18—**American Society of Civil Engineers,** Annual Meeting and Exhibit, Hotel Statler, New York, N. Y.

October 17–18—**American Ceramic Society,** Annual Meeting of Glass Div., Bedford Springs Hotel, Bedford, Pa.

October 17–18—**The American Ceramic Society, Inc.,** Pacific Coast Regional Meeting, Palace Hotel, San Francisco, Calif.

October 17–19—**National Society of Professional Engineers,** Fall Meeting, Grand Pacific Hotel, Bismarck, N. D.

October 21–22—**American Coke and Coal Chemicals Inst.,** Annual Meeting, The Greenbrier, White Sulphur Spring, W. Va.

October 21–25—**American Society of Safety Engineers,** Annual Meeting and Exposition, Conrad Hilton Hotel, Chicago, Ill.

October 22—**Association of Consulting Chemists and Chemical Engineers,** Annual Meeting, Hotel Belmont Plaza, New York, N. Y.

October 24–25—**American Society for Quality Control,** 12th Annual Midwest Conference, Chicago, Ill.

October 27–November 1—**Atomic Industrial Forum,** 4th Annual Meeting and 3rd Annual Trade Fair of Atomic Industry (AtomFair), Coliseum, New York, N. Y.

October 28–31—**American Nuclear Society,** 2nd Winter Meeting, Henry Hudson Hotel, New York, N. Y.

October 30–November 2—**Federation of Paint and Varnish Production Clubs,** 35th Annual Meeting and 22nd Paint Industries Show, Bellevue-Stratford Hotel, Philadelphia, Pa.

October 31–November 1—**Institute of Radio Engineers,** Annual Meeting, Henry Hudson Hotel, New York, N. Y.

November 2–8—**American Society for Metals,** 2nd World Metallurgical Congress and 39th National Metal Exposition.

November 3–8—**Society for Nondestructive Testing,** 17th Annual Convention and 2nd International Conference on Nondestructive Testing, Hotel Morrison, Chicago, Ill.

November 4–6—**National Paint, Varnish and Lacquer Assn.,** Annual Convention, Sheraton Park and Shoreham Hotels, Washington, D. C.

ASME Officers

The American Society of Mechanical Engineers has designated Oscar B. Schier II secretary-elect, to succeed, at the end of this year, the longtime secretary Clarence E. Davies. Mr. Schier has been a member of the ASME staff for many years, and deputy secretary since last December. He is a graduate of Lehigh University.

Another ASME elected officer, Frank W. Miller, ASME vice-president, has been elected to the presidency of the Yarnall-Waring Co. This company is located in Philadelphia, Pa.

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